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THE ELECTRIC RAILWAY.

More than sixty years ago the idea of the modern electric railway seems to have developed itself in the minds of a few experimenters far in advance of their time. We can see to-day that the work of Farmer, of Dal Negro, Davidson, Page and Davenport was literally prophetic, but these men lived and worked before any means of generating electricity on a large scale had grown to be commercially possible, and their experiments were looked upon as the interesting but useless work of dreamers and men who were seeking to do curious things rather than practical and useful ones.

It seems almost strange that ten years passed after the commercial exploitation of the dynamo machine before the project of electric traction was again taken up with that earnestness which leads to success. The brief interval of fifteen years has seen, in effect, the whole development of the vast system of electric traction which now gridirons the United States and is rapidly extending itself in older countries where it has had to meet prejudice and the delays of conservatism. There are now in the United States about twenty thousand miles of street railway, and of these only five hundred miles are operated by horses. It is to be regretted that in New York city alone there are to-day more miles of horse-operated track than in the whole of the New England states.

As one looks over the record of the development of electric railways he is struck at once with two features of this extraordinary advance. The first is the standardization of parts, of methods, of systems and of apparatus, which has made street railway operation under similar conditions practically identical wherever they are found; and the second is the increasing specialization of electric railways which is differentiating the various kinds into groups, each particularly fitted for the service it is called upon to perform. There are, to-day, practically three classes of electric railways with a fourth looming up as a very near possibility. These three are ordinary street railways, high-speed, medium-distance, suburban railways, and high-speed, long-distance, interurban or suburban railways operated practically upon the schedules and system employed by main-line steam railroads. There is no essential difference in the conduct and operation of an electric railway determined by the conducting system employed, and in considering the specialization of these types the engineering detail of conducting system, whether this be third-rail, conduit or overhead trolley, is outside of consideration. Practically all American systems operate on the direct-current at pressures between five hundred and six hundred volts, the cars being bridged across a more or less constant potential maintained between a fixed conductor and the track. While the alternating current has been used as a means of primary distribution of energy from central points to sub-stations, where it is transformed and converted for railway use, it has not yet in this country been applied directly to the car motors. In a paper by Mr. A. H. Armstrong, published in the ELECTRICAL REVIEW last week, the extraordinary advantages of electric traction using polyphase currents directly were brought out very clearly. There can be no manner of doubt that sooner or later the induction motor must be applied for railway purposes. In most respects it is closely analogous to the series-wound, direct-current motor in its action, but it possesses one advantage over any form of direct-current motor, which for railway work is of primary importance. This is its tendency to attain and maintain synchronous speed.

Two or three forms of polyphase traction have been suggested, among them being those employed on the Jungfrau and Lecco lines in Europe and another system, which we believe has not yet been tried in practice, but which promises excellent results. In this a synchronous motor is allowed to run constantly, at synchronous speed of course, upon the locomotive or under the car, and is connected to the running gear of the train, either electrically or mechanically as desired. With a system such as this, where there is no necessity for handling any current at a switch and where there is no discontinuity of ac-

tion, very high potentials may be used directly and thus the expense and trouble of maintaining transformer stations may be entirely obviated. The system of gearing necessary to connect a motor of this type and the running gear of the car may be made exceedingly simple and may range all the way from ordinary friction clutches up to a more complicated electrical method, which would possess, however, many real advantages in practice.

The operation of the induction motor directly is complicated somewhat by the difficulty in starting it. A method recently described in these columns whereby a high inductance and a high resistance in parallel are connected in each circuit of the rotor and installed within the moving parts of the machine so as to obviate the need for collector-rings and sliding contacts, seems to offer a possible solution to some of the difficulties incident to the operation of the induction motor in railway work. By the use of currents of sufficiently high periodicity and making the stator of the machine of many poles, so that it can be subdivided by a proper controller, a number of fixed running speeds may easily be attained. Indeed, when one considers it carefully, the problem of polyphase electric traction grows even simpler than that of direct-current traction, except in so far as the difficulties connected with the use of a triple feed system are concerned. With the coming of high-speed and heavy electric traction service, however, the trolley wire with the wobbling wheel running along its under side is going out of fashion and instead we find heavy construction with conductors made of solid and substantial sectional or other shapes. Anyone can easily see that with this type of fixed conductor a three-phase feeding system presents few if any difficulties beyond those encountered in the ordinary direct-current installation.

There is no doubt whatever that we will some day have polyphase electric traction direct. Sub-stations under such a system reduce themselves to simple transformer stations requiring neither attendance nor expensive buildings and suffering very little depreciation. The distances that may be covered with economy are greater than those that seem to be customary in the class of railway service to which such equipment naturally belongs. There seems, then, no reason beyond a certain conservatism which should retard the installation of such a system. It would be of the greatest value to electrical engineering if for no other reason than the necessity for an experiment which would be of untold value to the future of electric traction in general.

AN ITALIAN EXAMPLE.

On other pages of this issue will be found an article by Signor Enrico Bignami describing the equipment now being placed upon one of the main line railroads in the north of Italy, whereby this line will be changed over to an electric railway of the most advanced class. The Italians seem, even more than the Americans, to appreciate the use of electric traction and to desire to work out the economic salvation of their country by the utilization of the natural forces contained within it. Italy is a region of an admirable climate, conveniently situated for shipment of manufactured products and possessing an industrious and intelligent population, but it has, unfortunately, no coal whatever. This fact has been, for many years, a serious drawback and detriment to the establishment of manufacturing industries requiring power, but, of late, the possibilities of electrical engineering in developing and transmitting power have made it convenient to utilize the abundant and magnificent water powers with which the Italian peninsula is so richly endowed. The experiment—if it can be called experiment, seeing that it is on a large commercial scale—of operating a main line railway with polyphase currents generated by water power is one of a series that have been undertaken by the Italian railways, in collaboration with the Ministry of the Interior, in an attempt to develop and utilize the natural resources of the country. It seems foredestined to success, although one would rather like to see a more substantial conducting and current-taking device installed than that described by Signor Bignami. The line that has been chosen as the theatre of the experiment is one well known to tourists, passing through some of the most magnificent natural scenery in the world. It contains every variety of physical difficulty, such as grades, curves, tunnels and bridges, and will certainly give the electric system a fair opportunity to demonstrate its merits. It is curious that this latest demonstration of electrical engineering should be built in sight of the birthplace of Volta, and just one century after his monumental discovery that laid the foundation for modern electrical science.

At Clinton, Mass., the other day, a trolley car full of people ran off the track and slid to within three or four feet of the brow of a precipice overlooking the Nashua River. The motorman, as might have been expected of him, stuck to his post, screwed on the brakes tightly, threw out sand and managed to stop the car just before anything serious happened, and just an instant sooner than a man who would have lost his head could have done. Yet the newspaper despatch that relates the incident does not even mention the name of the faithful employee who showed nerve, courage and judgment in attending to his duty and thereby saved the lives of many of those entrusted to his care.

We have learned from a reliable source that the Poulsen telegraphone recently exhibited at the Paris Exhibition and described in the ELECTRICAL REVIEW, works with astonishing perfection and reproduces sounds with far greater accuracy than any variety of mechanical phonograph that has hitherto appeared. Whatever one may think of the utility of this apparatus as a register for telephonic conversations, he must admit that as a phonograph the new instrument promises to have a field of considerable usefulness. The mechanical phonograph has not, so far, given entire satisfaction, and its use has been limited practically to exhibitions and as a toy. Its early commercial promise was largely discounted by the lack of perfection in the apparatus, making it an entirely satisfactory substitute for the stenographer or other well-known methods of registering dictation. The new instrument possesses points of extraordinary merit and by the elimination of all mechanical action between the registering wire and the hearing apparatus, all of the extraneous noise usually present in the phonograph has been eliminated. It is to be hoped that the instrument will soon be brought out in commercial form and tested in practice to see whether or not it will prove as useful as there seems reason to expect.

Science Brevities

Dielectric Strength—The dielectric strength of a medium is measured by the fall of potential per unit of length along the lines of electric force which the medium will stand without breaking down and allowing a spark to pass. The minimum of dielectric strength lies at a pressure of about 0.7 millimetre in hydrogen, 0.3 in air, and about the same in carbonic acid, says an *Electrician* abstract. In hydrogen, the minimum strength is 233 volts per centimetre, in air 300, and in carbonic acid 373. The measurements are taken, according to E. Bouty, in a field between two plane and parallel electrodes. This gets rid of brush and glow discharges. When the variation of the dielectric strength with the pressure is studied, it is seen that, apart from the lowest pressures, the dielectric strength varies with the pressure in a lineal manner. If y is the dielectric strength and p the pressure, the relation between the two is expressed by the formulæ:

$y=1.4 + 63.33\,p$ in hydrogen.

$y=1.593 + 119.09\,p$ in air.

$y=1.703 + 144.4\,p$ in carbonic acid.

The constant term denotes, no doubt, the part played by the electrodes in opposing the passage of an electric discharge. The above values are those found for glass, whereas much higher ones were found by Max Wolf for brass. Wolf's direct relation between the coefficient of p and the inverse mean path is correct as between hydrogen and air, but only very roughly so in the case of CO_2.

Mechanical Action of Cathode Rays—Experimental determinations of the force exerted by cathode rays upon light movable bodies are as yet lacking, though Riecke has estimated the force acting upon a cathode shaped like a propeller. If the force thus found is regarded as that due to the reaction of projected particles, an amount of energy results which surpasses the whole energy of the cathode rays. It is, therefore, not permissible to deduce the kinetic energy of the cathode particles from such experiments, says Mr. Fournier d'Albe, in one of his abstracts. H. Starke has adopted a different arrangement. He used a cathode with a number of plates resembling a propeller. But the cathode was kept fixed, and the cathode rays impinged at an angle of 45 degrees upon a thin plate of aluminum suspended above the cathode by means of a thin platinum wire. The results are almost all negative. An influence machine gave nothing but irregular disturbances, probably due to electrical forces unconnected with the impact of cathode rays. An influence machine of 20 plates, yielding a discharge potential of 10,000 volts, and a current intensity of 10^{-7} amperes, gave something like an appreciative deflection, which indicated, however, that the force to be measured is below 10^{-4} dynes. The experiments are to be continued.

Electro-chemical Equivalent of Carbon—The following abstract, which appears in the *Journal* of the Chemical Society, is of a paper contributed by Mr. S. Skinner to the *Proceedings* of the Cambridge Philological Society. When a solution of potassium permanganate is electrolyzed with a carbon anode, 77 to 86 per cent of the gas liberated at the anode consists of carbon dioxide, the rest being carbon monoxide and oxygen. The total volume of gas liberated is nearly the same as the volume of oxygen liberated by the same current in a dilute sulphuric acid voltameter. The permanganate ion persists in solution even although a quantity of electricity more than sufficient for its complete decomposition is passed through the cell. The author finds the electro-chemical equivalent of carbon to be three times that of hydrogen. A cell may be constructed with a carbon rod in potassium permanganate, and a lead peroxide plate in dilute sulphuric acid, the two electrolytes being separated by a porous pot. The electro-motive force is 0.33 volt, and acts externally from the lead peroxide to the carbon. In this self-acting system carbon is consumed at the ordinary temperature.

Electrolytic Deposition—The following is an abstract of a paper contributed by Mr. Louis Kahlenberg to the *Journal fuer Physikalische Chemie:* In order to test whether Faraday's law is valid for non-aqueous solvents, solutions of silver nitrate in pyridine, aniline, phenyl cyanide and quinoline were electrolyzed, and the weight of silver deposited compared with that deposited from an aqueous solution in the same circuit. The weights respectively were as follows, those from the aqueous solutions being given first: 0.7836 gramme, 0.7819 gramme, 0.1788 gramme, 0.1780 gramme, 0.1612 gramme, 0.1603 gramme, 0.2501 gramme, 0.2452 gramme. In the quinoline solution there was evidence of a complicated reaction, as the silver was carbonaceous; in the other solvents it was firm and white. Experiments with lead and antimony gave very similar results. The work must be considered as preliminary, but it certainly tends to show that Faraday's law is valid for the non-aqueous solutions. It was found also that silver can be completely deposited in a compact white form from solutions in pyridine, or in aqueous pyridine, by a current of density from 0.17 to 0.25 ampere per 100 square centimetres cathode area.

Alloys—Among the papers read at the recent meeting of the British Association, at Bradford, was one by Mr. F. H. Neville on the "Nature of Alloys." The paper contained an abstract of the report of the British Association Committee on the subject, says the London *Electrical Engineer.* Thus it was stated that most students believed that certain definite chemical compounds existed in alloys. To prove this, however, certain means must be adopted to abstract the particular compounds. Ordinary chemical means of isolation were of no use under the circumstances. Fractional solution was effective in some cases, and by means of it several distinct metal compounds had been isolated from alloys, such as platinum-tin, copper-tin, zinc-copper and other compounds. Another method was by observation of the "freezing point;" the molten mixture was cooled down slowly and the temperature noted at which solid matter began to separate from the liquid. This varied with the proportion of the constituents, and by making many observations with varying proportions, a curve could be obtained of these solidifying temperatures, any irregularity pointing to the formation of something other than a mere mixture. By this means many interesting facts had been indicated which had subsequently been rendered evident by examination under the microscope. Valuable and interesting results had been thus obtained, both in this country and abroad. A remarkable instance of peculiarity was exhibited by mixtures of aluminum and antimony when all the mixtures froze at a higher point than either of the components, and showed two irregularities indicative of two distinct compounds. In these mixtures it appeared that the component that predominated to a considerable extent acted as a solvent to the compound formed with the other component; but as the proportion of the other component was increased, the conditions became reversed. Interesting results had been obtained by observing not only the freezing point, but also the point where the whole mass solidified, so that for every mixture the exact composition of the mass from which the compound had separated and of the separated compound was indicated. Rœntgen-ray photography has also been used to demonstrate the formation of these intermetallic compounds. A long list of known and supposed alloy compounds was given in the report, and it appeared that the atomic relations generally held by chemists did not hold in the case of alloys.

ELECTRIC TRACTION ON A MAIN LINE ITALIAN RAILWAY.

THE ELECTRICAL EQUIPMENT OF THE LECCO, SONDRIO AND CHIAVENNA LINE IN THE NORTH OF ITALY WITH A THREE-PHASE TRACTION SYSTEM USING INDUCTION MOTORS ON THE CARS.

BY ENRICO BIGNAMI.

Few of the problems that have been offered to the railway companies of Italy have attracted the interest, both of technicians and of the public, so much as that in process of solution by the Società Italiana delle Ferrovie Meridionale, operating the Adriatic system of railways, in collaboration with Messrs. Ganz & Company, of Budapest, for the application of electric traction upon 105 kilometres (66 miles) of railway north of Lecco. Both railway and electrical questions of great complexity have entered into the interesting problem presented.

The railway company mentioned has carefully investigated the application of electric traction to the operation of railroads, especially with a view to the utilization of the water-power which the Italian peninsula contains in such abundance. At the same time it is hoped to solve the difficult problem of the economical operation of secondary lines—a problem of special importance in Italy. To do this the company decided, solely as an experiment, to apply various modern systems of traction to two of its main lines embracing a considerable length of track and including a variety of difficulties for the new systems to contend with.

For lines upon which the movement of both freight and passengers is small, but which can not always be well served without increasing the frequence of trains, it has been decided to try the accumulator system. For lines combining a considerable movement of freight and local passenger traffic the system using generating stations and distribution of energy along the line by means of conductors has been adopted. It is the purpose of this article to describe the application of the later system upon a considerable length of railway as mentioned above, the general configuration of the line being shown in the map, Fig. 1. The line has a maximum gradient of 22 per cent and curves with a minimum radius of 300 metres, as well as numerous tunnels, especially upon the part of the line from Lecco to Colico (24 miles) which runs along the eastern side of the Lake of Como. This line serves the coast and towns along this beautiful lake and branches to Chiavenna and Sondrio which are respectively the two points of departure for passengers to the Engadine (St. Moritz) and Alta Valtellina (Bernina, Bornio and Stelvio).

These lines carry, especially in Summer, a considerable passenger traffic, representing some 65 per cent of their gross earnings, while the annual average of such earnings upon secondary Italian railways is about 35 per cent. Inasmuch as the region traversed is essentially a manufacturing country the movement at one time of passengers and another time of freight is practically continuous and fairly important throughout the year. The operation of the line presents, as may be seen, considerable difficulty. The conditions call for an electric railway service that shall, at certain times of the year, be able to meet the requirements of a primary line and as a consequence of this state of things service has been organized along the following general lines: (1) The complete separation of passengers and freight traffic; (2) a complete distinction in make-up and schedule between express trains running over the line from end to end and trains for local service; (3) designing the trains with a capacity sufficient for expected needs by increasing in advance both the number and weight of trains in service.

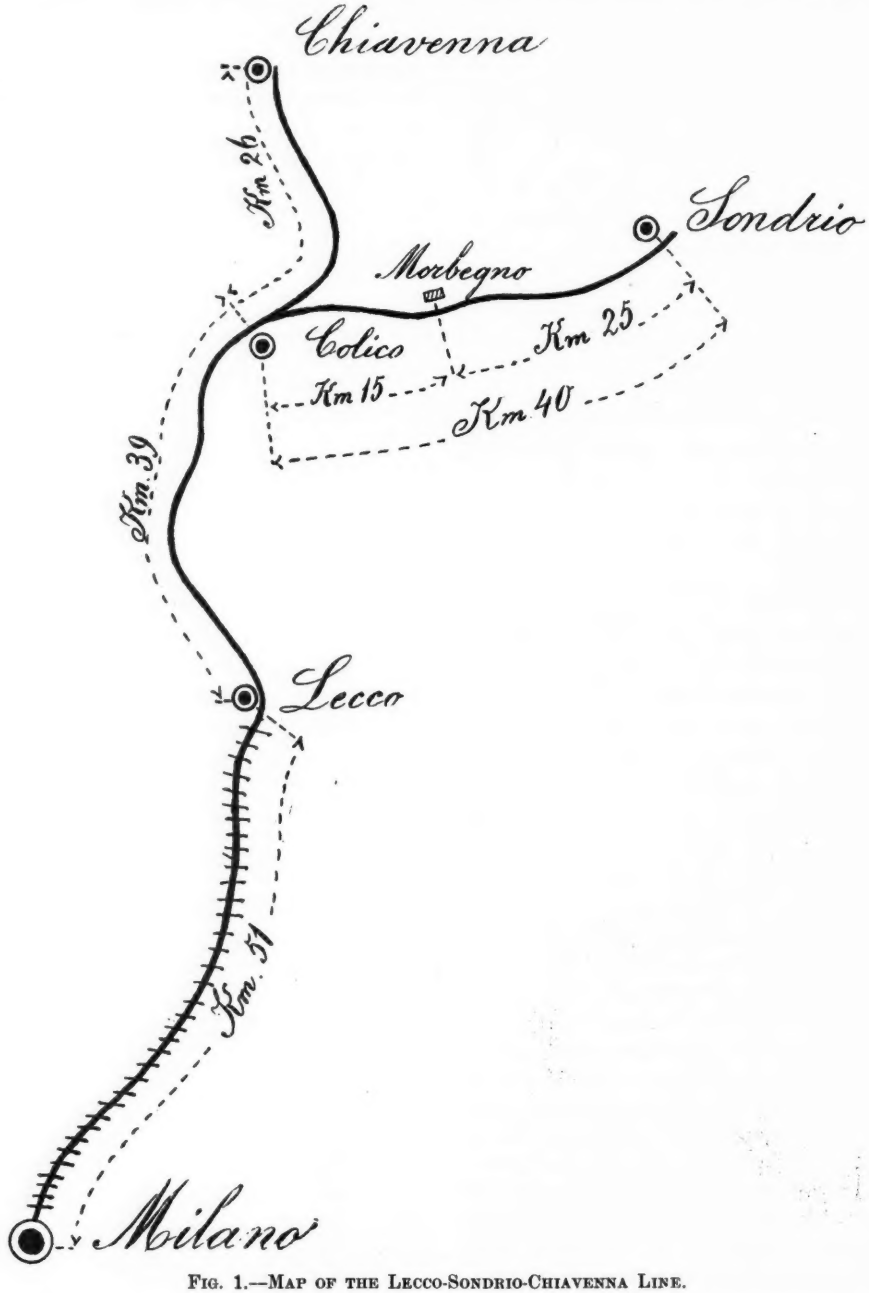


FIG. 1.—MAP OF THE LECCO-SONDRIO-CHIAVENNA LINE.

The passenger trains are drawn by an electric locomotive of about 300 horse-

power and weighing about 50 tons. This vehicle can carry 60 passengers and two tons of baggage and can draw four ordinary cars behind it with a speed of 60

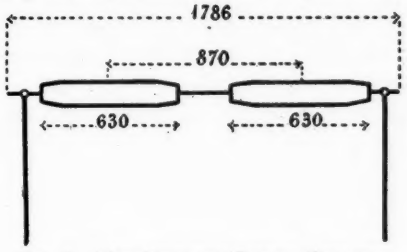


FIG. 2.—THE CURRENT-TAKING ROLLERS.

kilometres (37 miles) per hour upon grades up to a maximum of 10 per cent. For grades above this limit the speed of the train is cut in half. Freight trains are drawn by locomotives of 700 horse-power capable of pulling 250 tons up grades of 10 per cent and less with a speed of 19 miles per hour.

All of the difficult considerations that enter into the problem of economical distribution to great distances of a considerable amount of electrical power, and transmission of this power to moving trains, have led to the adoption of three-phase, high-tension current, both for the general transmission and for distribution to the motors on the trains.

The current for operating the plant will be generated directly at 20,000 volts at the water-power station at Morbegno, 16 kilometres (10 miles) from Colico, from which it is led by a three-conductor overhead line, using copper wire seven millimetres in diameter, to 12 sub-stations situated along the line at distances of 10 kilometres (6.2 miles) apart. These sub-stations reduce the tension to 3,000 volts and the current is distributed at this pressure to the motors by means of two trolley wires eight millimetres in diameter, the track being used for the third conductor of the three-phase system.

The two trolley wires are suspended six metres (18 feet 4 inches) above the track except in the tunnels, in which the low roofs require them to come down to within about 14 feet of the tracks. These wires are supported directly upon insulators made of ambroine protected by bronze shells and suspended from steel cross wires attached to poles or to bolts in the tunnel walls through the agency of porcelain insulators. In the tunnels the insulators are attached to iron hooks cemented into the vault. On the surface lines wooden poles are used.

The power station at Morbegno comprises four units, each consisting of a turbine and alternator direct-coupled together, of 2,000 horse-power each. The water wheels are of the regulation type and are provided with auxiliary-power governors. The alternating machines are of the rotating field variety and generate current, as mentioned above, directly at the high tension of 20,000 volts in each phase and under a frequency of 15 cycles per second.

The poles used along the line are mostly of wood and are set in pairs and guyed back. The lightning arresters used are of the American Wurts type having multiple short gaps and are put up at all the sub-stations and at the power house.

Crossings of the high-potential line and the trolley wires are protected by a system

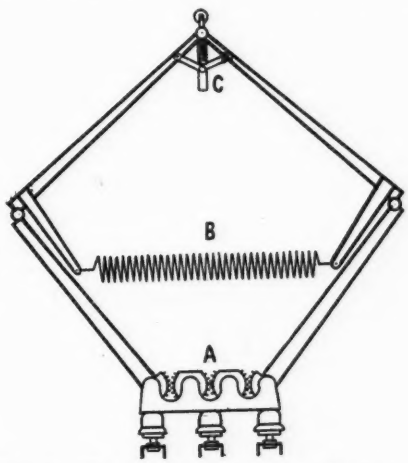


FIG. 3. WOODEN PARALLELOGRAM SUPPORTING THE ROLLERS.

of guard wires which are grounded. Crossings of the line over public roads and highways are also protected in the same way, fusible cutouts being put in so that a wire falling is short circuited and earthed by the guard wires and its fuses blown, leaving it dead.

Current is taken from the two trolley wires by means of two aluminum rollers, both mounted upon a small rod of boxwood well impregnated with insulating material and arranged as shown in Fig. 2. These rollers have an external diameter of a little more than three inches and, of course, at the full speed of the train turn with great velocity. Each is composed of a central cylindrical part 15 inches long terminating at its two extremities in truncated cones which are especially useful in passing switches and crossings.

The wooden rod carries the aluminum rollers upon bearings made with insulating balls and in its turn is carried at the top of two parallelograms of boxwood mounted upon a cast-iron base which is supported above the roof of the car by a number of heavy triple-petticoat porcelain insulators giving it a large supporting base. The lower parallelogram (Fig. 3) carries at the bottom of its articulation toothed sectors as shown at A. For the proper support of the rollers, so as to adapt them to run properly upon the wire in any position, two systems of springs are employed, the lower, shown at B, having a pull of about 200 pounds and serving to take care of considerable variations in the height of the rollers made necessary by variations in the height of the trolley wire. This large parallelogram carries at its top a second one, showing at C, with a much lighter system of springs which act with greater promptness and take care of the minor variations in the height of the wire.

By means of a collecting brush running upon a graphite collar current is taken from each roller and passes by means of a highly insulated cable, completely enclosed in a flexible metallic tube hinged at the corners of the parallelogram, directly to the primary windings of the principal motors. To facilitate the passage of the contact apparatus at switches the conductors between stations are doubled in such a way that over each track there run four wires, the wires corresponding to the same phase being held 60 centimetres apart on ordinary track and separating gradually at branch lines, one set going along and over each line of track so that the contact rollers pass from one to the other without need of guides or of interruption of the current. In order to avoid short circuits one conductor is interrupted for about 10 feet at the point of the switch, a boxwood rod impregnated with a special insulating material taking its place at this gap. In order to avoid any interruption of current upon the primary

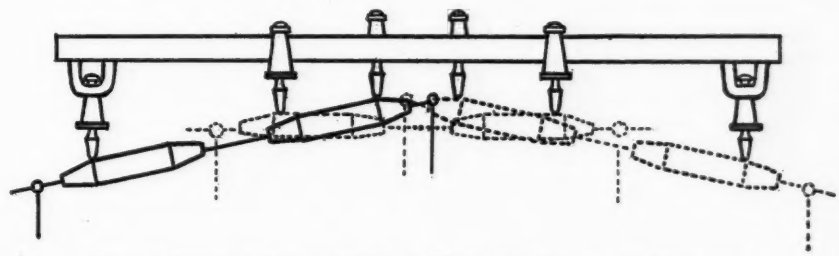


FIG. 4.—SHOWING ARRANGEMENT OF WIRE AND ROLLERS AT SWITCHES.

circuit of the motors the car also carries a trolley at each end, the two being about 32 feet apart and one running on a wire of each phase. By this arrangement in combination with the roller described, broken contact is impossible.

Short circuits between the conductors of different phases at switches or junction points are avoided by arranging the contact rollers on a slant, as shown in Fig. 4. By this simple arrangement much complexity is avoided, the overhead structure in no case weighing more than 180 pounds complete. The 3,000-volt current connection to the motors is protected by metallic tubing surrounding the cables carrying it, these being connected with the ground. The primary winding of two of the four induction motors on the car are directly connected with the contact roller and their two secondaries or rotor circuits may be connected either to a liquid resistance or to the primary circuits of the other two motors with which the car is furnished. In the secondary circuits of the latter are inserted variable resistances. If the four motors are coupled two by two in series the velocity of rotation of the two rotors will be practically half that of the primary rotating field and also half that which the two primary motors would attain if fed directly from the line. This arrangement gives two running speeds of 60 and 30 kilometres per hour, but in order to avoid abrupt passage from one to the other, a liquid rheostat is inserted into the secondaries, giving an adjustable resistance.

Since the insulation of the induction motors is similar to that of the transformers, and since all parts in contact with the high-potential current are completely protected with a metallic casing in communication with the ground, perfect safety to passengers and employees is attained. Notwithstanding that the cars are fed from a distributing system, in order to obtain the most absolute observance of signals on the line to which the system is applied, the current may be completely shut off from any train by means of the switch and commutating apparatus of Sig. Bianchi-Servettaz and of Messrs. Thomson-Webb, whenever it is signaled to stop. At the same time the air brakes are automatically applied.

Line switches are so arranged that shunting and making up trains at stations may all be done with the electric locomotives.

It will be noted that from the trolley the current passes directly to the primary of the motors through high-insulation cables enclosed in metallic tubes. As mentioned above, all these circuits and the primary of the motor are completely enclosed in metallic casings and the regulation of speed does not require any handling of parts of the circuit at high potential. In addition to this, all of the metallic external parts of the apparatus, such as the base of the trolleys, the protecting tubings, the motor casings, controller handles and all of the frame of the car are well connected with the track, which constitutes one of the three conductors of the three-phase system. In looking at this arrangement one does not hesitate to haz- and the idea that the question of operating high potentials upon electric railway vehicles when one of the conductors is the track, is a simple and easily-solved problem.

In this conviction one is strengthened by the brilliant and numerous experiments that have been made in this direction by the constructing engineers having the road in charge. Tests made a few days ago with the first vehicle, running at a speed of 85 kilometres (53 miles) per hour, were fully successful. It is expected that the line will be in full operation from end to end early in the Spring of 1901.

THE APPARENT INCREASE IN THE AIR-GAP OF DYNAMOS AND MOTORS DUE TO TOOTHED ARMATURES.*

BY C. F. GUILBERT.

It is generally understood that the apparent increase in the air-gap of a dynamo, due to the use of a toothed armature, can be determined by calculating the magnetic resistance of the air-gap upon the hypothesis that the cross-section of the flux is constant for the whole air-gap and equal to the mean between the area of the polar face and that of the surface of the armature teeth.

In using this method the results attained are a little too small for the apparent air-gap, and this, in apparatus working well below saturation, such as induction motors, may lead to quite important errors.

My purpose is to apply to this calculation a method based upon an hypothesis which is exceedingly simple and, at the same time, more correct than that mentioned above. This method is analogous to another I have already used in calculating the magnetic leakage between two parallel surfaces.

Let AB (Fig. 1) represent a portion of the polar face of a dynamo corresponding to the width of one tooth and the space between two teeth of the toothed armature. The portions AB and A′B′ may be taken to be plane and parallel. Let us, then, calculate the magnetic resistance of the parallelopipedon comprised between the two rectangles, AB and A′B′.

Referring to Fig. 2, let l and l_1 represent the lengths AB and A′B′, δ the perpendicular distance between these, and connect by the dotted line A and A′, B and B′, and prolong these lines to their intersection at C, situated at a distance a from the line AB.

The section of an element da ($2a_1$ being the angle ACB) by a plane parallel to AB at a distance x is evidently

$$L\left[d\lambda_1 + (d\lambda - d\lambda_1)\frac{\delta - x}{\delta}\right],$$

L being the size of the machine, λ and λ_1 the lengths comprised between the axis of the pole and a line passing through C.

The magnetic resistance of the element comprised between the two planes separated by dx is, then,

$$\frac{\frac{dx}{\cos x}}{L\left[d\lambda_1 + (d\lambda - d\lambda_1)\frac{\delta - x}{\delta}\right]}.$$

This expression may be simplified by substituting

$$\frac{\lambda_1}{\lambda} = \frac{a - \delta}{a}$$

and also

$$\lambda - \lambda_1 = \frac{\delta}{a}\lambda$$

from which

$$d\lambda - d\lambda_1 = \frac{\delta}{a} d\lambda_1$$

We have, then, for the expression of the resistance of the elementary parallelopipedon

$$\frac{\delta\, dx}{L\cos a\left[\delta - \frac{\delta}{a}x\right]d\lambda} = \frac{1}{L\cos a\, d\lambda}\,\frac{dx}{1 - \frac{x}{a}}.$$

The magnetic resistance of the wedge-shaped element comprised between the two planes A′ B′ and A B, is, therefore:

$$\frac{1}{L\cos a\, d\lambda}\int_0^{\delta}\frac{dx}{1 - \frac{x}{a}} =$$

$$\frac{a}{L\cos a\, d\lambda}\log_e\frac{a}{a - \delta}.$$

The magnetic conductance of the same element is

$$d\frac{1}{\mathcal{R}} = \frac{L\cos a\, d\lambda}{a\log_e\frac{a}{a - \delta}}.$$

Replacing $\cos a$ by its value $\frac{a}{\sqrt{a^2 + \lambda^2}}$

we have;

$$d\frac{1}{\mathcal{R}} = \frac{L}{\log_e\frac{a}{a - \delta}}\,\frac{d\lambda}{\sqrt{a^2 + \lambda^2}}$$

*Translated from *L'Industrie Electrique.*

The conductance of the parallelopipedon AB, A′B′ is then,

$$\frac{1}{\mathscr{R}} = \frac{L}{\log \frac{a}{a-\delta}} \int_{-\frac{l}{2}}^{+\frac{l}{2}} \frac{d\lambda}{\sqrt{a^2+\lambda^2}},$$

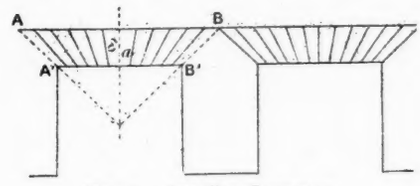


FIG. 1.—AIR-GAP INCREASE.

$$= \frac{L}{\log_e \frac{a-\delta}{a}} \log_e \frac{\frac{l}{2} + \sqrt{a^2+\frac{l^2}{4}}}{-\frac{l}{2} + \sqrt{a^2+\frac{l^2}{4}}}.$$

By replacing $\frac{a}{a-\delta}$ and $\frac{\lambda}{2a}$ by their values $\frac{l}{l_1}$ and $\frac{l-l_1}{2\delta}$, we obtain, after multiplying the numerator and denominator of the second factor by the numerator:

$$\frac{1}{\mathscr{R}} = \frac{2L}{\log_e \frac{l}{l_1}} \log_e \left[\frac{l-l_1}{2\delta} + \sqrt{1+\left(\frac{l-l_1}{2\delta}\right)^2}\right].$$

The magnetic resistance, in the case of a smooth core armature, for a portion of the width of the pole-face λ being $\frac{\delta}{L\,l}$, it is evident that the apparent air-gap δ' bears to the actual air-gap the ratio

$$\frac{\delta'}{\delta} = \frac{l}{2\delta} \frac{\log_e \frac{l}{l_1}}{\log_e \left[\frac{l-l_1}{2\delta} + \sqrt{1+\left(\frac{l-l_1}{2\delta}\right)^2}\right]} \quad (1)$$

from which δ' can be deduced:

$$\delta = \frac{l}{2} \frac{\log_e \frac{l}{l_1}}{\log_e \left[\frac{l-l_1}{2\delta} + \sqrt{1+\left(\frac{l-l_1}{2\delta}\right)^2}\right]}. \quad (2)$$

The preceding method of calculation can be applied also to alternating-current motors when the stator and rotor have tunnel-shaped slots. In this case we may assume that the division of the flux is homogeneous in the air-space as shown in Fig. 3. The preceding formula may then be applied to the calculation of the apparent air-gap.

If δ is always the actual separation of the iron surfaces, the value of l to introduce in the expression is $\frac{\delta}{2}$, and it is necessary to take the sum of the two apparent half-gaps corresponding to the total gap as, consequently:

$$\delta' = \frac{l}{2} \frac{\log \frac{l}{l_1}}{\log \left[\frac{l-l_1}{\delta} + \sqrt{1+\left(\frac{l'-l_1}{\delta}\right)^2}\right]} + \quad (3)$$

$$+ \frac{l'}{2} \frac{\log \frac{l'}{l'_1}}{\log \left[\frac{l'-l_1'}{\delta} + \sqrt{1+\left(\frac{l-l_1'}{\delta}\right)^2}\right]}$$

Applications: Take first, for example, a direct-current dynamo, in which the air-gap is 0.5 centimetre, and wherein the teeth and the spaces between them

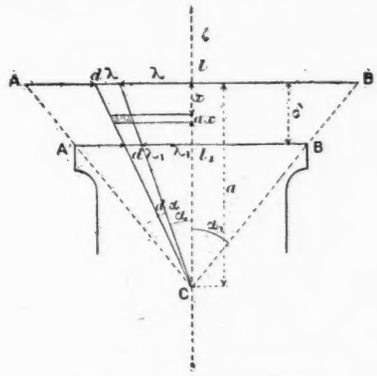


FIG. 2.—AIR-GAP INCREASE.

are of the same widths. Then $l = 2$ and $l_1 = 1$. The apparent air-gap is $\delta' = \frac{\log 2}{\log 2.414} = 0.785$, and the ratio of the apparent to the actual air-gap is $\frac{\delta'}{\delta} = 1.57$.

Let us apply the formula (3) to an induction motor having a rotor diameter of 60 centimetres and an actual air-gap of 0.15 centimetre. The stator has 48 slots and the teeth are 3 centimetres wide; the rotor has 122 slots with teeth of 1.3 centimetre width. Then

$$l = \frac{\pi.60}{48} = 39.3 \text{ mm.}, \; l_1 = 30 \text{ mm.};$$

$$l' = \frac{\pi.60}{122} = 15.45 \text{ mm.}, \; l'_1 = 13 \text{ mm.}$$

From the formula (3) may be deduced:

$$\delta' = \frac{39.3}{2} \frac{\log 1.31}{\log \left[\frac{9.3}{1.5} + \sqrt{1+\left(\frac{9.3}{1.5}\right)^2}\right]} + \frac{15.45}{2} \frac{\log 1.19}{\log \left[\frac{2.45}{1.5} + \sqrt{1+\left(\frac{2.45}{1.5}\right)^2}\right]}$$

$$= \frac{39.3 \times 0.117}{2 \times 1.096} + \frac{15.45 \times 0.0755}{2 \times 0.55} = 2.1 + 1.06 = 3.16.$$

The ratio of the apparent and actual air-gaps is thus

$$\frac{\delta'}{\delta} = 2.1$$

or the air-gap is practically doubled.

If the method mentioned in the first part of this article had been used, taking the mean between the tooth-faces of the stator and rotor, the value of the air-gap would have been found to be

$$\frac{\delta'}{\delta} = \frac{2\pi D}{N_1 l_1 + N' l'_1} = \frac{2\pi \times 60}{48 \times 3 + 122 \times 1.3} = 1.26.$$

N and N′ being the numbers of slots in the stator and rotor, respectively. This value is much too small, and shows the importance of a more rigorous method for calculating this important ratio.

FIRE IN BROOKLYN POWER HOUSE.

ELEVEN SURFACE LINES AND THE FIFTH AVENUE "L" STALLED.

A short circuit in the big power house of the Brooklyn Rapid Transit Company, situated at Third avenue and Second street, South Brooklyn, set fire to the great structure last Wednesday morning, destroyed a big switchboard, melted all the insulation off the feed wires along Third and Fifth avenues from Twenty-third street to Flatbush avenue, and did about $50,000 damage to the building and machinery.

For over an hour the principal surface lines and the third-rail system of the Fifth

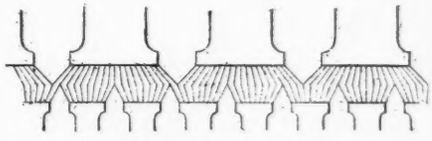


FIG. 3.—AIR-GAP INCREASE.

avenue elevated were stalled, but the company's officials took prompt action and managed to make connections with the Bay Ridge and Kent avenue power houses. Traffic was resumed on most of the lines affected before nightfall, and the greater part of the wires repaired well enough for temporary use.

Electromobile Ambulances for Roosevelt Hospital.

Roosevelt Hospital, in New York city, has just received a gift of two electric ambulances which have a speed of 16 miles an hour and are controlled by a newly-designed brake, which, the inventor claims, will bring them to a full stop within six feet while running at full speed. The vehicles are rubber-tired, weigh nearly three tons apiece and cost $3,000. Similar ambulances are being constructed for the Presbyterian and New York Hospitals.

THE ELECTRIC EQUIPMENT OF THE GLASGOW, SCOTLAND, TRAMWAYS.*

A FINE BRITISH TRACTION SYSTEM USING AMERICAN APPARATUS.

The tramway system of Glasgow is one of the most important in the country, and its importance hitherto is vastly augmented by the splendid electrical equipment which is now being installed. This equipment presents features, both of magnitude and of method, which in some respects are unique in the United Kingdom. America has a few systems of the sort, but not on a very extensive scale. New York, however, promises speedily to surpass Glasgow in magnitude of application of the particular method of distribution now to be considered. We, therefore, have much pleasure in presenting some exact details of the system which is now being installed in Glasgow, and which will, to a large extent, be in operation next Summer.

Readers are, doubtless, fairly familiar with the history of Glasgow tramways, but a few words on the subject may be acceptable. Constructed in 1871 by the corporation, as a kind of defense against the threatened invasion of tramway syndicates, they were then leased for 23 years to the Glasgow Tramway and Omnibus Company. That company carried on the work, but in the light, at least, of recent experience, they never realized the possibilities of the development of traffic, even with horse traction. No doubt they were a good deal badgered by the corporation, or it would not be true to its character of "pushfulness," and when the close of the lease approached the parties failed to come to terms for its renewal. One need not return to that old quarrel, but the result was that the corporation, on July 1, 1894, began the service themselves, with new cars, horses, buildings, and, in fact, everything. Nothing was taken over from the company. Under their act of 1870, the corporation had power to work the tramways, so that there was no difficulty on that score. Owing to the dispute with the company, however, they had to incur greater expense than might otherwise be necessary, in view of the fact that the horse equipment was only to be temporary till some form of mechanical power was adopted. Under the corporation policy of a very frequent service and exceedingly low fares, the traffic has developed enormously.

The corporation began their inquiries as to the best form of mechanical traction long before the lease to the company expired. Indeed, if we remember aright, they were examining the cable system and the infancy of the electric system as far back as 1890. In the following year, powers were obtained to use mechanical traction, and the committee of inquiry was appointed. Then followed the long series of investigations and the visits to Europe and America, and the result, as every one knows, was a decision in favor of the trolley wire. The "experimental" Springburn line was opened on October 15, 1898, and in the issue of this journal of October 13 of that year a full description of it was published. In November last year the extension to the south side came into use, and an account of it was published in these columns on December 7.

So satisfactory were the financial results of the Springburn line that on January 5, 1899, the town council resolved that the whole of the tramways of Glasgow should be converted to the electric trolley wire system. They had long delayed, but now that a decision was arrived at, all energies were concentrated on getting as great a proportion of the system as possible electrically equipped before the opening of the Glasgow International Exhibition, in May, 1901. Bailie Paton, chairman of the tramways committee; Mr. John Young, general manager of the system, and Mr. W. E. Clark, engineer, lent themselves to the task with untiring energy. The conversion of the track at once begun, and on March 16 last year it was decided that the tramway power generating plant should be altogether distinct from that for electric lighting. This was

FIG. 1.—THE GLASGOW TRAMWAYS, SHOWING ROUTES, GENERATING STATION AND SUB-STATIONS.

*From the *Tramway and Railway World*.

a wise decision in view of the magnitude of both undertakings and of the importance of absolute accounting of the expenses of each department. Mr. H. F. Parshall, M. Inst. C. E., had just been appointed consulting engineer for the tramways scheme, and he favored the segregation. The town council also went in for a vigorous policy of expansion. Last year they obtained an act authorizing the construction of 19 miles of double track, much of it (including the line to Paisley) outside the city boundary, and further extensions will be proposed next year.

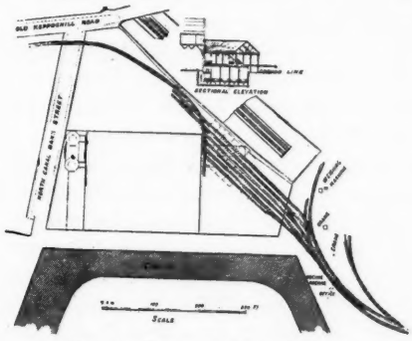


FIG. 2.—PLAN OF STATION SITE.

There were some 400 cars in use at the beginning of last year, and the average consumption of current by the few electric cars was found to be 7.2 kilowatts, or 9.6 horse-power at the car. In view of the extensions and of the probable increase of traffic, Mr. Parshall, taking this power consumption as a basis, figured out a scheme for 600 cars, with provision for an increase to 900 cars. The three-phase, alternating-current system of distribution was, on the strong recommendation of Mr. Parshall, decided upon. The total cost, including the new extensions, will be far above a million sterling, and may be nearer two millions.

We need not enter into the question, keenly discussed at the time, of the relative merits of one three-phase, high-pressure generating station with sub-stations *versus* a number of separate stations generating direct current at 500 volts, nor need reference be made to the discussion about the contracts for the main engines, which was largely dealt with in these pages last year.

Mr. Parshall at once proceeded to prepare plans and specifications, and, as these were made ready, tenders were asked, and contracts for some months were continually being let. Particulars of these have been published from time to time. Some have only been arranged recently, but when all is completed and the new lines are under way, a table of the contracts and prices should form most interesting study for those engaged in the business.

The permanent way reconstruction was early begun, and the new lines now building are of a similar type to the converted horse tracks. The total length of the tramways up till now is about 38 miles, practically all double track, or, including the leased lines in Govan, 42 miles; but the extensions will bring up the total to about 61 miles, serving a population of some 850,000 people. The accompanying map (Fig. 1) shows the Glasgow tramway system and the position of the generating station and of the sub-stations, five in number. The new rails are of the steel grooved-girder type, weighing 98 pounds per yard. They are supplied in 60-foot lengths—the advantages of which have been previously pointed out in these columns—and are laid on the usual six-inch bed of concrete. The conduit for the feeders is between the tracks. The rail, as used on straight track, has fish-plates which weigh 74 pounds per pair, each 31 inches long, and secured by eight one-inch bolts. The rail section is a little different from that used on the Springburn electric line, the change being made with the object of obtaining a better fishing angle for the fish-plates. On curves a rail with a thicker lip is used, weighing 105 pounds per yard. Both sections are seven inches high, with a seven-inch base, and are remarkably substantial. The tread is brought well over to the inside, so that the weight of the car is carried right above the web, and any tilting stress is thus obviated. The groove,

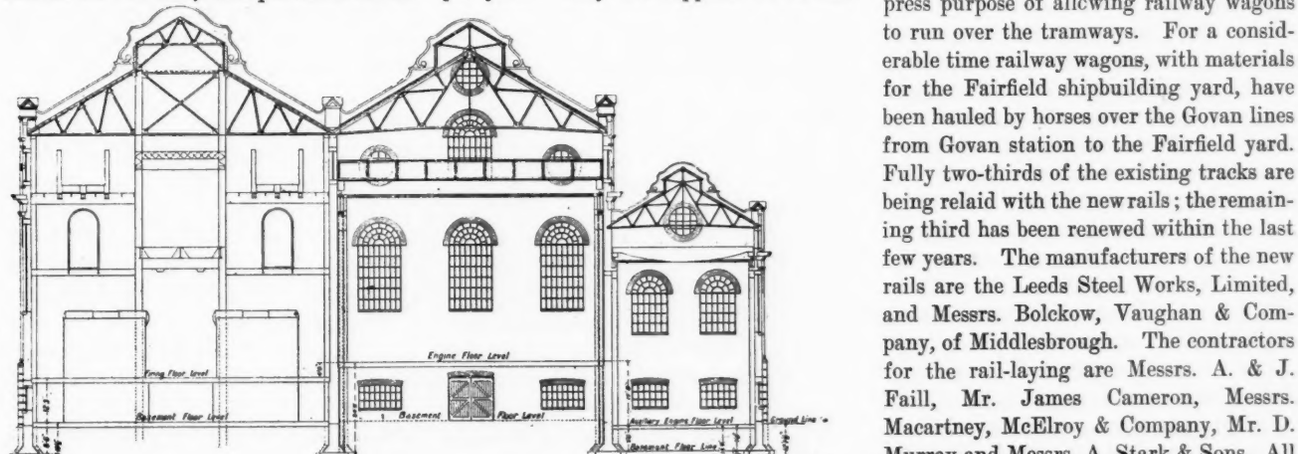


FIG. 4.—TRANSVERSE SECTION OF MAIN GENERATING STATION.

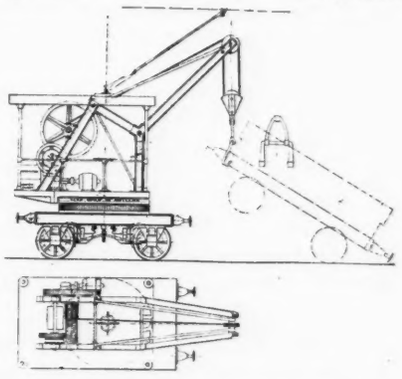


FIG. 3.—TEN-TON ELECTRIC CRANE USED FOR TIPPING COAL CARS AT STATION.

which is one and one-quarter inches deep by one and one-quarter inches wide, is quite large enough to take the flanges of ordinary railway wagons should it be found advisable to use these during the night for any purpose. In fact, the Glasgow gauge of four feet seven and three-quarter inches was designed for the express purpose of allowing railway wagons to run over the tramways. For a considerable time railway wagons, with materials for the Fairfield shipbuilding yard, have been hauled by horses over the Govan lines from Govan station to the Fairfield yard. Fully two-thirds of the existing tracks are being relaid with the new rails; the remaining third has been renewed within the last few years. The manufacturers of the new rails are the Leeds Steel Works, Limited, and Messrs. Bolckow, Vaughan & Company, of Middlesbrough. The contractors for the rail-laying are Messrs. A. & J. Faill, Mr. James Cameron, Messrs. Macartney, McElroy & Company, Mr. D. Murray and Messrs. A. Stark & Sons. All the junctions and special work are being carried out by the tramway department's own staff.

The bonds for the rails have been supplied by R. W. Blackwell & Company, Limited, and consist of two long No. 0000 B. & S. solid copper bonds (with Daniel's terminals through the web of the rail) extending over the fish-plates, and two No. 0000 B. & S. flexible bonds

with Daniel's terminals in the base of the rail. For these details as to the permanent way we are indebted to Mr. John Young, the general manager.

We now come to a highly interesting part of the undertaking, and, in fact, the essence of the scheme. Dublin and Dalkey, Middlesbrough, and so forth, are small examples of three-phase distribution, but here we have a gigantic specimen of it. The system adopted is that the whole of the energy is generated at one convenient point and distributed over a wide area, not merely with economy, but without transgressing any of the Board of Trade cast-iron regulations. Taking a general view of the whole undertaking, the scheme may be briefly expressed by saying that the energy is generated in the form of three-phase alternating currents at a pressure of 6,500 volts, and transmitted to five sub-stations, At these it is transformed by means of static transformers to a potential of 310 volts, and is then converted by rotary converters from three-phase alternating currents to continuous current at 500 volts for running the cars. The five substations, as shown on the map, are situated as follows: A, Coplawhill; B, St. James street, Kinning Park; C, Hayburn street, Partick; D, Dalhousie, off New City Road; E, Whitevale, off Rochester street, Gallowgate. Land for a generating station was acquired, at a heavy cost, at Pinkston, near Port Dundas, on the north side of the city, and work was begun upon it in April, last year. The site is a convenient one, for it is not far removed from the centre of load of the whole tramway system, and it is close to the Forth and Clyde Canal, and to the lines of the Caledonian and North British railways, so that there are ample facilities for the supply of condensing water and of coal. Fig. 2 is a plan of the site showing the relative position of the buildings, railway sidings, outside coal storage and the canal. Coal bunkers are built on the outside of the end wall of the boiler house, with a capacity of about 4,000 tons. They are arranged so that part of them will be filled from the North British Railway line and part from the Caledonian. The two railways are on different levels, the North British line being on a level with the generating station floor, while the Caledonian is 15 feet higher. There are six railway tracks running on the top of the bunkers, and the latter are arranged at two levels to accommodate the railways. The wagons are tipped by electric cranes, as shown on the drawing (Fig. 3). Two electric locomotives of a plain but substantial design are to be used for handling the coal trucks in the sidings. Overhead wiring is provided in the sidings to supply current for their operation.

The power station building consists of a steel framework clothed with Glasgow plastic clay brick. The section shown in Fig. 4 gives an idea of the construction. The framework, which contains 1,300 tons of steel, was contracted for by the Riter Conley Company, Pittsburgh, U. S. A. The contract time for supply and erection was 12 months. The brick work was let to Messrs. Thomson & Sons, Glasgow. All the weight of the building and roof is carried on the steel work. No pains nor expense has been spared to make the building substantial, and the foundations have been carried down to the solid rock, this meaning, in some places, a depth of 28 feet below the surface.

The building is 224 feet long by 200 feet broad, and the height from the basement level to the lowest member of the roof girders is 88 feet. The station is divided into three sections, as follows: Boiler room, 244 feet by 84 feet; engine room, 244 feet by 75 feet; auxiliary plant room, 244 feet by 40 feet. The height of the boiler room from the floor level is 70 feet, that of the engine room 64 feet, and that of the auxiliary room 52 feet. There are two chimney stacks, each 263 feet high from the ground line. They are built of brick, with ornamental stonework, and have an internal diameter of 16 feet, with a firebrick lining. The total cost of the building and stacks, exclusive of all machinery, has been very high, but, in the opinion of the consulting engineer, it is one of the most substantial he has ever seen.

There are in all 16 boilers of the Babcock & Wilcox make, supplied by the Babcock & Wilcox Company, Renfrew. They are divided into eight batteries of two boilers each, four batteries on each side of the boiler house. Each boiler is capable of producing 20,000 pounds of steam per hour at a working pressure of 160 pounds per square inch. Mechanical stokers of the new Babcock & Wilcox chain type are employed. These are driven from two main shafts situated in the basement, and each shaft is operated by an electric motor of 30 horse-power. The motors are interconnected, so that each motor can drive either of the shafts or both of them. The coal is carried from the outside bunkers, previously referred to, into storage bunkers on the top of the boilers, by means of two mechanical bucket conveyors, built by the Mirrlees, Watson & Yaryan Company, Glasgow. The bunkers on the top of the boilers have a capacity of about 2,400 tons. Each conveyor can handle 50 tons an hour, and they run at a speed of 45 feet per minute. The coal passes from the overhead bunkers into the boiler hoppers through specially designed chutes with weighing arrangements, so that all the coal used for each boiler is weighed.

The water for the boilers is taken from the town mains through two storage tanks placed on girders between the two chimneys. These tanks are each 25 feet long by 12 feet broad by 10 feet deep, and their capacity is 18,000 gallons each.

There are four motor-driven boiler feed pumps of sufficient capacity to deliver 8,000 gallons per hour against a pressure of 180 pounds per square inch. They were supplied by the Mirrlees, Watson & Yaryan Company. In addition, Messrs. J. & G. Weir, Glasgow, provided a boiler feed steam pump capable of delivering 16,000 gallons of water per hour against the same pressure. There are two fuel economizers, supplied by the Claycross Company, Derby. Each is capable of dealing 12,000 gallons of water per hour, and to raise its temperature from 90 to 160 degrees Fahrenheit.

The steam piping from the boilers to the engines is simply arranged. Each battery of boilers is connected by a seven-inch steam pipe into a nine-inch cross main, leading into the main header, which is 16 inches in diameter, and is in two parts, connected by an expansion bend. This arrangement aims at supplying the steam in the shortest and most direct way from the boilers to the engines. Under ordinary conditions each main engine will take the steam from that section of boilers which is opposite to it. The pipes from the header into the engines are 14 inches in diameter for two of the engines and 15 inches diameter for the other two. The pipes are overhead, as there is only one row of engines in the engine room and the length of pipe is short. All the piping is of lap-welded steel and extra heavy sections.

Passing to the engine room, the main engines are four in number, and space is provided for the addition of two more in the future. Each engine, which is direct-coupled to a three-phase generator, is designed to work at 4,000 indicated horse-power as its normal rate of working, but it is capable of developing a maximum of 5,000 indicated horse-power while still running at its normal speed of 75 revolutions per minute. These are by far the largest engines in this country for electric traction purposes, and, until very recently, there has been no engine nearly so large in any country for driving traction dynamos. They are of the vertical, inverted,

compound, condensing, three-cylinder type, with Corliss valve gear. Two of them have been supplied, through R. W. Blackwell & Company, Limited, by the E. P. Allis Company, Milwaukee, U. S. A., and two by Messrs. Musgrave & Sons, Bolton. The appended particulars apply more particularly to the Allis engines, but the Musgrave machines are similar except in some minor details. The diameter of the high-pressure cylinder is 42 inches and that of each of the low-pressure cylinders 62 inches, all with a five-foot stroke. The three-cylinder type engine was adopted in preference to the ordinary two-cylinder compound variety as likely to give a greater steadiness of speed—a matter of special importance in a three-phase plant. The three cranks are, of course, set at angles of 120 degrees from one another. As indicating the massive nature of these machines, the following dimensions of the bearings of the crank shaft are of interest. Starting from the high pressure end, the first and second journals are 22 inches in diameter by 36 inches long; the third and fourth, 24 inches by 36, and the fifth and sixth, 32 inches by 64. An outer bearing outside the generator is 30 inches by 48. The diameter of the shaft through the hub of the flywheel is 36 inches. The sizes of the crank pins are: High-pressure, 20 inches by 12; first low-pressure, 16 inches by 12; second low-pressure, 12 inches by 12. The ponderous flywheel is 24 feet in diameter and weighs 220,000 pounds, or over 98 tons. It is built up of sections of a special mixture of cast-iron of high strength, and the rim is 26½ inches by 26 inches. The weight of the engine complete is 700 tons. The guaranteed steam consumption does not exceed 14 pounds per brake-horse-power per hour. The governors are such that the speed is not to vary more than one and one-half per cent above or below the normal speed under any fluctuations from no load to maximum. The angular velocity is not to vary more than one-fifth per cent during a revolution at any constant load. In addition to the automatic control governor there is also an emergency governor designed to cut off the entire supply of steam should the speed of the engine increase by more than five per cent above the normal. Fig. 5 is a drawing of the combined engine and generator,

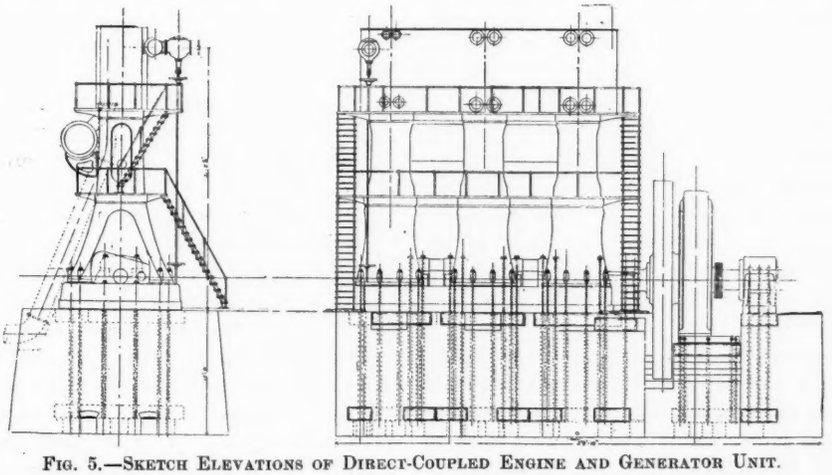


FIG. 5.—SKETCH ELEVATIONS OF DIRECT-COUPLED ENGINE AND GENERATOR UNIT.

and from this some idea will be obtained of the appearance of these enormous units. Measured over all each of the engines is almost 43 feet in length, or 52 feet including the flywheel and generator; 35 feet in height and 24 feet in depth from back to front.

We now come to the generators. Each is designed for an output of 2,500 kilowatts at a pressure of 6,500 volts when running at a speed of 75 revolutions per minute. This is the highest voltage which has yet been used for traction work in this country, the pressure employed on the Central London Railway being only 5,000 volts. The generator has 40 poles, so that at its rated speed of revolution the periodicity of the three-phase currents is 25 cycles per second. The machine is of the revolving field type with stationary armature. The armature frame is mounted on sliding foundation plates, so that it may be moved sideways along the shaft in order to allow access to the field coils. The generators are to be capable of maintaining synchronism between themselves and a load of rotary converters (situated at varying distances) at all loads up to 100 per cent overload. The exciting current is not to exceed 250 amperes for each generator at full non-inductive load. The guaranteed efficiencies of the generators at full load is 96 per cent; at three-quarter load, 95 per cent, and at half load, 93 per cent. The weight of the revolving fields is 84,500 pounds (nearly 38 tons), while that of the armature and frame is 98,000 pounds (almost 44 tons). The generator complete weighs 202,000 pounds, or the enormous total of fully 90 tons. The diameter of the field frame is 16 feet 8 inches, and the diameter across the outside armature frame is 21 feet 6 inches. Fig. 6 is an elevation of one of the generators, which, as in the case of the engines, are the largest for traction work installed in the United Kingdom. The contractors for them, as also for the exciters and the auxiliary generators, are the British Thomson-Houston Company, London.

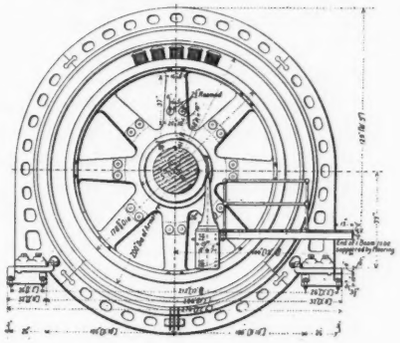


FIG. 6.—ELEVATION OF GLASGOW GENERATOR.

The 100-volt direct current for exciting the fields of the main generators is supplied by six exciter dynamos. These are of the six-pole type, each of 50 kilowatts capacity, and each direct-coupled to a vertical steam engine of 85 horse-power, running at a speed of 300 revolutions per minute. The six engines were supplied by Messrs. W. H. Allen, Son & Company, Bedford.

Besides these, there are two large auxiliary units in the generating station for the purpose of driving the auxiliary plant there, and also for supplying power direct to the sub-stations and car depots during the night for repairs, lighting, moving cars in sheds, etc. Were it not for the magnitude of the main plant, these auxiliaries might be regarded as forming a respectable installation in themselves, as they are quite powerful enough to operate regularly, say, about 100 cars. The engines are of the vertical cross-compound type, each of about 800 horse-power at normal load, but capable of developing a maximum of 1,000 horse-power continuously. The conditions of governing are the same as for the main engines, and the weight of each engine is 122 tons. The cylinders are respectively 22 inches and 44 inches in diameter, and the stroke is 42 inches. Each engine is coupled to a 500-volt direct-current generator of 600-kilowatt capacity. These are 10-pole machines and run at 90 revolutions per minute. The continuous current is, of course, conveyed to the sub-stations by cables totally independent of those for the main three-phase transmission. The engines were supplied by Messrs. Duncan Stewart & Company, Glasgow, and the dynamos by the British Thomson-Houston Company. The generators are designed to over-compound from 500 volts at no load to 600 volts at full load. The guaranteed efficiency at full load is 94 per cent; at three-quarter load, 93.8 per cent, and at half load 93 per cent. The total weight of each generator is nearly 47 tons.

(To be concluded.)

THE APPLICATION OF ELECTRICITY TO AGRICULTURE.

BY GEORGE E. WALSH.

The application of electricity to manufacturing industries, transportation and city lighting is so general that we hear little of its development in another line that is only a little less important. It is not a new thought or idea to apply electricity to agriculture either for the purpose of stimulating the crops in their growth or for lessening the labor of cultivating the fields and transporting crops. But in the last year or two important experiments and tests have been going on abroad and at home in this direction.

The horseless or electric farm, as sometimes described, is still a myth, but in California and the great grain fields of the Northwest electric automobiles and harvesters are actually in operation, and there are a few modern farms where the power of a small stream of water flowing through the land has been utilized for generating electricity for lighting purposes and for running farm machinery. The fact is the modern farmer is becoming almost as much of an engineer as he has been a tiller of the soil. Agriculture has been reduced to a science, and agricultural machinery represents an industry in which millions of dollars are invested. A good deal of this machinery is operated by horse-power, but steam and electricity are being gradually introduced on the large farms to take the place of horse power. The average western farm of 100 acres and upward represent an outlay of several thousands of dollars for machinery, and, in order that the same shall be operated in the cheapest and most effective way, electricity and steam are being tried in propelling them.

Recently our American consul at Madgeburg, Germany, described in some detail an electrical farm that was operated not far from a German city, and this description applies to a modified extent to a number of farms in the west. The power was derived from a stream whose waters were dammed up to secure the necessary fall to turn a large turbine wheel. By the construction of a large reservoir, sufficient water was stored to keep the turbine wheel in operation during the dry season. The waste water from the dam was then conducted in a series of canals so that it would irrigate a considerable tract of land further down the stream. The power thus obtained was utilized for generating electricity, which was conducted to various parts of the fields and barns on overhead wires. Nearly all the farm machinery was operated by this power, and there were electric motors, pumping machinery, harvesters, cutters, threshing machines, churns and other machines driven by electricity.

The success of such an electric farm depends upon the question of cost and its location and size; but while this German horseless farm was run as an experiment we have practical and profitable electric farms in this country that have demonstrated the value of electricity in agriculture. The more general application of electricity to agriculture has been recommended by the Department of Agriculture wherever there are streams of sufficient power and force to be of value. Heretofore the streams have been utilized almost entirely for irrigation purposes, and immense sums have been spent in constructing reservoirs to store the water. But this same water that is stored for irrigation purposes could first be used for generating power. It is estimated by competent engineers that the stored waters of the great western rivers, which are now solely used for watering the farms in Summer, could exert power enough to supply the whole country along their courses with electricity sufficient to light the houses and operate farm and manufacturing machinery. At present this immense power is all wasted. It has been stored for a single purpose, while it could be utilized for two.

But it is not alone along the line of operating farm machinery that the application of electricity to agriculture attracts attention. There is still a belief that electricity may yet revolutionize our crops through another way. Electricity has been known for many years to exert a peculiar effect upon the life of plants and trees. If applied in sufficient force and quantity it kills, but when administered properly it quickens and stimulates the life of plants as it affects the human system when medicinally applied. There is a good deal of talk just now about the destruction the electric wires of street lines are doing to the shade trees of our towns and cities, but it may not be known to all who read of these accounts that this same power is of beneficial value to trees as well as plants when applied in the right manner.

Nearly 20 years ago experiments were made in applying electricity to growing plants, and the Russian savant, Spechneff, succeeded in demonstrating the fact that electricity greatly stimulated the growth of both seeds and plants. He first applied it to the seeds and succeeded in making them germinate much quicker than when not so treated, and then he applied it to the growing plants. So successful was he in the latter work that he raised radishes in a short time of an abnormal size. Some attained a length of 17 inches and 5 inches in diameter. The next successful experimenter in this field was Lemstrom, who applied electricity to the seeds and plants of wheat, rye and other grains. Like his predecessor, he produced marvelous results, and almost seemed to double the yield of grain in a given tract.

These early investigations and experiments formed the beginning of the modern attempt to apply electricity to agriculture. In France experiment farms have been established where atmospheric electricity is collected and applied to the seeds and plants for the purpose of demonstrating its value. This French system of electroculture has furnished some interesting and valuable data. It has demonstrated that atmospheric electricity collected by the "geomagnetifère," as they call it, and distributed to the plants by a network of wires, is superior to the more powerful currents of artificially manufactured electricity.

In this country experimenters have been alive to the possibilities of the value of electricity as a stimulating agent for crops and probably some of the most accurate and trustworthy experiments have been made on this side of the Atlantic. A plant-forcing house installed with electricity has been in operation for two or three years at Cornell University, and some remarkable results have so far been obtained. The arc light has for the most part been employed in this country, and at the Cornell forcing house it has proved of great value. The main question whether these results will be of practical value to the horticulturist and farmer has not yet been definitely decided, but for certain special lines of propagation of plants electricity has proven of the greatest value.

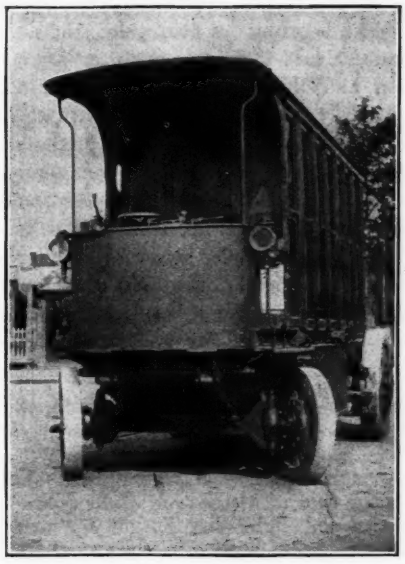
The application of electric light at Cornell to plants has not been confined to any particular kinds of crops, but flowers, vegetables, grains and fruits have been subjected both to the overhead rays and the underground wires. It was found that some of these plants respond quickly to the electric light. Spinach, radishes and lettuce could be so forced under the effect of the arc light that they would grow twice as fast as in the ordinary garden, and indeed they could be forced so rapidly in their growth that they would quickly go to seed. Likewise, flowers have shown a wonderful responsiveness to the effect of the rays at night, and, in many

cases, the colors of the flowers have been greatly intensified, while in others directly the opposite effect was obtained. The flowers faded away and proved useless. Violets have been made to blossom in three weeks when exposed to the electric rays at night and the sunshine in the day. Tulips of the richest colors have been produced. The deep colors of the flowers, such as dark red, blue, scarlet and pink presented a handsome appearance for a few days, and then faded.

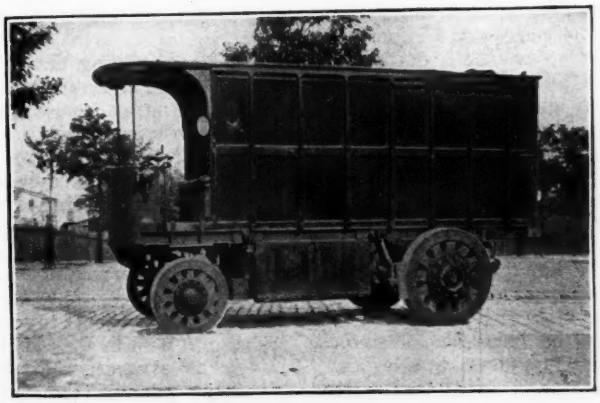
All plants show a marked attraction toward the electric light, and they will incline toward the light at night and straighten up again in the day time. Just how this knowledge of electricity will prove of practical value to the horticulturist and farmer is a question that the experimenters are now trying to discover. Sufficient is known, however, to make us confident that electricity will have a great bearing on the future of our agriculture, and some day it may revolutionize farming as it has transportation and house-lighting.

A Twenty-Ton Electromobile.

The illustrations herewith show front and side views of a very heavy electric automobile vehicle recently constructed for the Raffinerie Say, in Paris, and used for the transportation and delivery of refined sugar in that city. The outside dimensions of the vehicle are 18 feet in length, over all, by 7 feet 6 inches in width. Unloaded, the vehicle weighs 11 tons, including its battery in working order, and is capable of carrying a load of 9 tons, thus making the weight upon its wheels 20 tons. This is regarded as the usual working capacity of the vehicle, but satisfactory tests have been made with a total weight of as much as 28 tons. The speeds vary up to 12 kilometres (7½ miles) per hour. The motors are two in number, hung on the rear axle and geared to the wheels in the usual way. They are arranged to operate in series and parallel with various combinations of the storage battery. The battery consists of 80 cells of the Phœnix pattern and has a sufficient capacity for a run of 40 kilometres (25 miles). A curious novelty has been introduced in the steering gear, the two front wheel forks being operated by individual electric motors geared to them, and turning being accomplished by a manual switch in the hands of the operator. It is claimed that one man can easily manage this gigantic vehicle under all circumstances. As a protective measure it is fitted with sand boxes like a locomotive, the sand being poured out by spouts in front of the rear wheels.



TWENTY-TON ELECTROMOBILE, FRONT VIEW, SHOWING STEERING GEAR.



TWENTY-TON ELECTROMOBILE, SIDE VIEW, SHOWING BATTERY SUSPENSION.

It is stated that, owing to the interesting results already attained, the Raffinerie Say is about to order and put in use 10 other vehicles of the same general type.

The American Telephone and Telegraph Company.

[*From Boston News Bureau, September 29.*]

Telephone and telegraph people are holding daily conferences in New York which may or may not have important results. In connection with these conferences there is a scheme which has long been in contemplation by large financial interests to consolidate the telephone and telegraph interests of the United States.

What the result of these conferences, or of these large plans of amalgamation, may be, can not be foretold or even guessed at, at the present time.

One important fact, however, has come to the surface and that is as to who Theo. N. Vail, formerly general manager of the American Bell Telephone Company, represented in his large holdings of telephone shares in the Old American Bell Telephone Company. Mr. Vail held at one time the largest block of Bell Telephone stock, and this not many months ago. The general belief was that he represented in these holdings the Western Union Telegraph Company.

We are able to state that that block of stock, however, in no way represented the Western Union. What Mr. Vail did not own personally in that block of stock, President Mackay, of the Postal Telegraph Company, did, and probably does to-day.

It is said that Mr. Mackay is held in high esteem by the American Telephone Company's management and is frequently consulted upon questions of policy.

A director of the American Telephone and Telegraph Company says the company is spending more money on new construction this year than in any other year in the history of the telephone companies and that it was never making more money than at the present time.

Electrical Waterworks.

East Cleveland, Ohio, will shortly have an automatic water pumping system driven by electric motors. Current will be supplied from Cleveland, and the pumps will be run without any further attention than an occasional oiling. The water, taken from the 10-inch Cleveland main, will be forced up the hill back of the village into a large steel reservoir. The height of the reservoir is sufficient not only to give the house pressure required, but will be enough for fire plugs, thus enabling the local fire companies to dispense entirely with their old fire engines.

Plans for the erection of a plant to light the entire yards and property of the Baltimore & Ohio Railroad Company, at Cumberland, Md., are now under consideration.

SYSTEMS AND APPARATUS FOR LIGHT AND POWER DISTRIBUTION.

BY CHARLES PROTEUS STEINMETZ.

(*Continued from page 349.*)

For these reasons it is very undesirable to choose a higher frequency than 25 cycles for converter work, and where the continuous-current service is a very small part of the total load only, and thus 60 cycles chosen to accommodate the alternating load, it is preferable rather to use motor generators entirely or partly for the continuous-current supply.

To understand the phenomenon of hunting, let us take the simplest case—a generator of absolutely steady and constant electro-motive force feeding a converter or synchronous motor over a circuit of certain resistance and self-induction or reactance, with a constant load on the converter. The usual theory of the text books then shows that the counter electro-motive force of the converter adjusts itself to a definite phase relation with regard to the generator electro-motive force, depending upon the load and the excitation.*

Closer investigation shows, however, that the phase of the counter electro-motive force of the converter, and thus its speed, and in consequence thereof the current, can pulsate around a mean position, and the power supplied by the generator pulsates correspondingly, with a period depending upon the electro-motive forces, the impedance, the momentum of the moving masses, and several other constants, but usually of a magnitude of somewhere near one cycle per second. During the time of acceleration the generator supplies an excess of power, which is stored by the moving masses, and returned during retardation, where the generator supplies less power than the load on the converter represents. This period is entirely definite and independent of wave shape or engine pulsation, although the latter may start the oscillation.

Since several of the constants entering the equations of hunting are beyond the control of the designer as well as the user, the tendency to hunting can not always be avoided but the hunting can be suppressed by damping devices, where the conditions are made favorable therefor.

The most efficient damping device is copper bridges between the pole pieces. During the oscillation the alternating power supplied, and thus its armature reaction in the converter, pulsates, and since the mean value of alternating and continuous-current armature reaction neutralize each other, an oscillating armature reaction remains (which, during excessive hunting, causes the vicious periodic sparking, by producing an active magnetic field at the brushes). By intercepting this oscillating magnetic field by the low resistance closed circuits of the copper bridges between the field poles, the currents induced therein exert a damping action and thus suppress the oscillation. Obviously 25-cycle converters, with their higher armature reaction, are preferable in this respect also. As compromise frequency, 40 cycles has been proposed, and has, in some instances, been used to advantage. As a rule, however, a compromise frequency is undesirable for your class of work as being not best suited to any application. For small transformers and for arc lighting, especially indoor lighting, 40 cycles is rather below best practice, while for converters and slow-speed generators, it is inferior to 25 cycles, although better than 60 cycles. The proper field of application of 40 cycles is power and light distribution for mills, factories, etc., with numerous small and moderate size motors, especially of the induction type, and incidental incandescent and arc lighting, either directly from low-voltage, slow-speed alternators, or by a small number of large step-down transformers. For very long transmission lines of very high voltage, under circumstances excluding 25 cycles, 40 cycles is also to be recommended.

In the generating station the number of poles of the generator obviously is directly proportional to the frequency. At 75 revolutions a 25-cycle generator requires 40 poles, and a 60-cycle generator 96 poles. The smaller the number of poles, however, with the same engine, the steadier is the frequency. In the steam engine, with the steam impulses the speed periodically rises and falls. Assuming, for instance, in a cross-compound engine with four impulses per revolution, that the engine speed rises 1-10 per cent during the impulses and drops behind as much between the impulses. For each impulse the armature moves, in a 40-polar, 25-cycle alternator, over 10 poles, and thus dropping behind 1-10 per cent, amounts to 1-10 per cent of 10 poles, or 1-100 of the pitch of one pole. Since each pole gives one-half wave of alternating current, or 180 degrees of phase, 1-100 pole amounts to a dropping behind of the alternator wave by 1.8 degrees; and if at the same moment another alternator connected in parallel is ahead by the same amount, the electro-motive forces of the two machines are out of phase with each other by 3.6 degrees, and a cross current flows between them, which equals sin 3.6, or six per cent of the short-circuit current. With a 96-polar, 60-cycle alternator moving over 24 poles per impulse, the phase displacement will be 8.6 degrees, giving a cross current equal to 14.4 per cent of the short-circuit current.

It immediately follows that the larger the short-circuit current, that is the closer the regulation of the machine, the greater must be the cross current. Thus too close regulation is undesirable, and with such large units unnecessary also. As a rule, the lowest regulation permissible by the nature of the load gives the most reliable and best operating machine.

Experience has shown that deviation from uniformity of the frequency by 2.5 to 3 degrees in phase (that is, a maximum phase displacement between two alternators of 5 to 6 degrees), constitutes about the upper limit of good practice. This is obviously much more difficult to secure with high than with low number of poles. It should preferably be secured by the design of the engine, that is by balancing the momentum of the reciprocating masses against the steam impulses, and not by very large flywheel capacity, since large flywheel capacity rather predisposes to hunting.

With multiple expansion engines, however, especially of the vertical type, the speed variation due to the finite length of the crank shaft is frequently more serious than that due to the steam impulses. While the former is less in magnitude, it extends over a greater period, one-half a revolution, so that the phase displacement caused thereby is larger.

Essential, however, is that the uniformity of rotation of the engine unit is maintained also when operating in parallel with another unit.

The steam engine governor inherently tends to hunting. That is, if the engine speed is slightly slow, the governor opens and admits more steam, sufficient not only to carry the load at the normal speed, but also to accelerate it, and not only this, but it keeps opening until the speed has recovered. That means when the speed has become normal, more steam is admitted than required, and the engine continues to accelerate until the governor begins to close, and now over-reaches in the same manner in closing. Obviously the higher the flywheel capacity, the slower is the engine to recover its speed, and the greater the over-reaching.

When one engine only is operated, the governor usually comes to rest soon. When running in parallel with another machine, however, the governor of the second engine may take up the oscillation, thus causing a hunting between the governors.

The remedy necessarily must be looked for in the design of engines and their governors.

While the uniformity of speed during the rotation should be as great as possible, a close speed regulation from no load to full load is not necessary nor desirable with large units, but it is rather preferable that the speed from no load to full load should drop several per cent to insure good division of load between the machines, operated in parallel.

Where the main station is near the centre of distribution and continuous current supplied therefrom, either a converter sub-station may be located in the main

*Such a phase relation, that in the polar diagram the generator electro-motive force, the converter electro-motive force, and the electro-motive force consumed by the current in the line impedance form a triangle, and the product of the current and the projection of the electro-motive force upon the current equals the load.

generating station, or all or a number of the generators built as double-current machines, that is machines producing alternating as well as continuous current.

Double-current generators are limited to those sizes and speeds and number of poles, where simultaneously a good alternating and a good continuous-current generator can be designed. Thus in most cases they are not feasible for anything above 25 cycles.

They require step-up transformers.

As a rule, if not a very large part of the power is used immediately as continuous current, ordinary alternators are preferable.

The double-current generator is specially suited in a system of supply from a number of continuous-current stations, of which one predominates in size and economy of operation. By thus installing double-current generators in this station, they can be used during the peak of the load to supply continuous current, while during light load the smaller stations may be altogether shut down and power supplied to them from the double-current generators, thereby maintaining more constant load on the main station.

In such cases inverted converters can be used also, to change the continuous-current power to alternating for transmission.

When operating rotary converters inverted, that is, changing from continuous to alternating current, precautions have to be taken to keep them from racing. In the inverted converter, as in the continuous-current motor, the speed depends upon the field strength. Lagging current, however, demagnetizes the field, and thus, if in an inverted converter the current begins to lag (as, for instance, by starting a converter from it), its speed increases, and may increase so rapidly that it can not be controlled by the field rheostat.

Obviously when running in multiple with alternating-current generators, this danger does not exist, but the inverted converter speed is held by the generator, provided the latter is large enough not to be accelerated by the inverted converter.

While similar to the converters in their appearance, the double-current generators differ essentially therefrom in their internal constants. In the double-current generator, alternating and continuous current flow in the same direction and the armature reaction and consequent field distortion are due to the sum of the two currents. Thus the cross section of the armature conductor must be large and the armature reaction moderate. In the converter the actual armature current is the difference between alternating and continuous current, and the armature reactions neutralize, thus a very small conductor section is used to secure best commutation, and very high nominal armature reaction to secure high output and stability. A double-current generator used as converter is more liable to hunting, and a converter as double-current generator to sparking and heating.

It is essential for the efficiency and reliability of operation of such a system, to choose the simplest possible arrangement, and the least number of transformations of power. Wherever, therefore, the sub-station can be reached with 6,000 or 10,000 volts, a direct generation of the transmission voltage is preferable to the use of the step-up transformers. The 6,000 or 10,000 volt generator is just as reliable and efficient as a low-voltage machine.

One important feature to be considered in the design of the generating station is, nowhere to bring the total power, or even a very large part of it, close together. Thus the cables leading from the generators to the bus bars, and the feeders issuing from the bus-bars, should be separated in a number of different conduits as far apart from each other as possible. We must consider that at the voltages and powers existing in such stations a short circuit in a cable is liable to destroy, or short circuit any cable within 10 feet distance, or more. In a lesser degree the same applies to the sub-station.

The high-voltage conductors, bus-bars, etc., should preferably be kept away from the operating switchboard altogether, the instruments supplied by transformers, and all switches operated by relays, to secure safety to life.

A further important feature, in stations where the power is transmitted by cables, is the protection against excessive rise of voltage as caused by resonance phenomena in making and breaking circuit, etc., the more as insufficient protection of the cable usually does not make itself felt immediately, but shows as a rapid deterioration of the cable, breakdowns beginning to occur after some months, and then appearing with increasing frequency.

Where overhead lines and cables are used in the same system, lightning protection must be provided wherever a cable joins an overhead line, and every such place constitutes a weak point of the system.

In the customers' circuits the power is used:

(A) As continuous-current, three-wire system with about 250 volts between the outside conductors, for the central part of the distribution.

(B) As alternating current for outlying districts and pioneer work.

(C) As constant current, either continuous or alternating, for series arc lighting.

(A) To change the three-phase power received from the generating station to 250-volt, constant-potential, continuous current, the rotary converter is the most suitable apparatus. It requires step-down transformers. In the chain: Generator, transmission line, transformer, converter, the transformer is the weakest link regarding over-load capacity, since at overloads the temperature of the transformer rises at a much faster rate than in the converter or the generator. In all these apparatus the losses consist of two parts—a constant loss, practically independent of the load, as hysteresis, friction, shunt field excitation, and a loss increasing with the square of the load: I^2R in the main conductors and brushes. Obviously where the latter loss is small and the main conductors so imbedded in the iron as to transfer their heat rapidly thereto, as in the converter, and to a somewhat lesser extent in the generator, the temperature rises quite slowly with the load, being rather proportional to the total loss in the apparatus. In the transformer, however, the conductors must, of necessity, be messed together and separated from the iron, so that the temperature of the coil is more independent of that of the iron. That means that at double load, where the loss in the conductor is four times as large, the temperature rise will be very much greater than in the converter, for instance, where, at double load, the temperature rise may be increased only 50 per cent or even less. Since in emergencies an overloading may not always be avoidable, especially in a system where the first consideration is to maintain the service under all conditions, it appears to me advisable to select the transformer capacity very liberally. For the same reason I prefer air blast transformers for this class of work, since the air, as expansive fluid, reaches everywhere, and therefore the liability to local heating is small, while with oil as cooling medium, due to the sluggishness of the oil stream, pockets may be formed in which the oil does not properly circulate and a destructive local rise of temperature is liable to occur.

It is desirable to give each converter unit a separate bank of transformers, since when operating several converters from the same transformers, a pulsating cross current flows between them, if the position of the brushes is not very carefully adjusted, and causes sparking and heating.

The simplest, and thus the most reliable, arrangement is to consider the converter and its transformers as one piece of apparatus, put in and out of service together, and connect converter and transformers permanently together on the low-potential side by conductors of the least possible length. With the heavy low-voltage alternating current in these conductors, self-induction and mutual induction easily become formidable with any greater lengths of conductors. The only case where the possibility of transferring any converter to any transformer would be of advantage is, if one converter and a transformer of another converter are disabled simultaneously. It appears to me by far preferable, however, in this rather improbable case to heavily overload the remaining units than to go to the excessive complication inherent to a transfer device.

The converter unit can consist either of two machines of 125 volts, connected between neutral and outside conductors on the three-wire system, or of one 250-volt machine. The former has the disadvantage to commutate the current twice, but the advantage to establish and maintain the neutral. It is usual in continuous-current generating stations, where face-commutator machines are used, since this type of machine lends itself best to 125-volt construction.

(To be continued.)

Electric Railways

The stockholders of the Cleveland, Ohio, Elyria & Western Railway Company met recently, and decided to extend their line from Berea south to Medina, a distance of 17 miles.

The much talked of trolley between Freehold and Asbury Park, N. J., is again being revived. This time Red Bank people have the matter in hand and are confident that the project will go through.

A power house for the Indianapolis & Martinsville Traction Company, Ohio, to cost nearly $1,000,000, has recently been authorized and the contracts signed by the company. The plant will be at Mooresville.

Work has been commenced on an electric road that will run from Toledo, Ohio, to Sylvania, and may possibly go farther, into Michigan. Postmaster W. E. Chappelle, of Sylvania, brings word that ground has been broken and that grading is now in full sway in the vicinity of Sylvania.

The common council of the village of Crosswell has granted a franchise to the Detroit, Mich., Lake Huron & Lexington Railway Company to operate an electric railway within the village limits. According to the provisions of the franchise the road is to be completed and in operation by December 31, 1901.

The councils of the village of Chippewa and township of Stamford, N. Y., have granted franchises to the Fort Erie Ferry Railway Company, the former calling for the completion of the proposed electric road through the village by November 1, 1901, and the latter the extension of the line to Falls View by September 15, 1901.

The city council of Sante Fe, N. M., has given a 50-year franchise for an electric street railway to M. W. McGrath, of Denver, who represents Montreal capitalists largely interested in mining in New Mexico. The plans are said to contemplate the building of lines connecting Sante Fe, Las Vegas, Cerrillos, Bland and Albuquerque, with branches to the mines throughout the Cochiti district.

The issuing of a charter to the Oley Valley Railroad, for the purpose of building and operating a line from Reading to Boyertown, Pa., indicates that active steps will be taken at once to begin the work of building the line, and it is believed that it will be in operation before next Spring. The directors are: John A. Rigg, president; Richmond L. Jones, Isaac Eckert, Jerome L. Boyer, James A. O'Rielly and Wm. R. McIllvain, of Reading; E. J. Moore, Philadelphia; Henry C. Moore, Trenton; H. W. Biddle, Chester, and R. N. Carson, Montgomery County.

There is scarcely a doubt that Rochester and Buffalo, N. Y., will be connected by electric road by the time the Pan-American Exposition opens next Spring. Plans for the road have been fully surveyed, capital has been interested, the consent of the vast majority of property-owners along the line has been secured, and practically all that is needed now is the approval of the State Railroad Commission, which, it is believed, will be obtained without opposition. The route along which the trolley line will run is the famous Ridge Road, both historic and picturesque, and probably as famous a stretch of roadway as there is in western New York.

Use of Hot Wire Instruments as Shunt Ammeters.

To the Editor of Electrical Review:

I note in your issue of September 12 that Mr. J. Franklin Stevens still insists that "as a shunt ammeter the hot wire instrument is a distinct failure." Mr. Stevens, in his first article, claimed that it was a distinct failure for two reasons: First, that it took a fall of potential of six volts to bring the instrument across the scale; and, second, that if the instrument was calibrated on direct current and used on alternating current then the difference in inductance in the shunt and instrument would introduce an error of 10 per cent.

Now Mr. Stevens is willing to believe that hot wire shunt ammeters can be made that require only 0.3 volt drop for full scale, but goes on to argue that even then they do not meet the full requirements of a shunt instrument. An unbiased reading of Mr. Stevens's first article would convey the impression that the instrument was deficient inasmuch as it took six volts instead of 0.3 volt, and such was the error to which I wished to call attention. Such a statement, I think, is entirely unjustifiable, even if it were from actual figures obtained on one sample instrument. There is nothing said about the range of the instrument, or whether is was an instrument built for a special purpose, and, what is more to the point, whether the instrument and shunt were in calibration.

It is true that the D'Arsonval instrument is the standard and accepted type of shunt ammeter for direct-current work, and also that it can be made to operate on .03 volt; but it can only be used on direct current, and is, therefore, no more a standard for alternating-current work than is any other piece of apparatus that can not be used interchangeably on either kind of current. That feature of the hot wire ammeters, however, is quite important, as any one will readily agree who tries to design an artistic switchboard, and then has to put instruments of one kind on the alternating-current panels, and radically different ones on the exciter panels.

In regard to differences on alternating current and direct current, Mr. Stevens gives 10 per cent as a fair average difference, this again from his personal experience; I suppose the same experience by which he got six volts drop around the shunt. As was pointed out in my former article, such a thing is impossible, for the instrument in itself has some self-induction, and, therefore, the conditions that must exist before such a result can be obtained; *viz.*, no self-induction in the instrument, and the inductive drop of the shunt equal to one-half of its ohmic drop, are impossible. Of course, the higher the frequency the more apparent the discrepancy will appear, but will never amount to one per cent on any commercial frequency. As for inductive circuits, I fail to see how they could in any way affect the reading of the ammeter.

In my previous article, I did not want to write a treatise on the advantages of hot wire instruments. I wished merely to call attention to two glaring misstatements made by Mr. Stevens. The other statements upon which Mr. Stevens invites correction can, for the most part, be overcome by good design. Such, for instance, are heating errors, which is a question of a mounting for the hot wire which will have the same coefficient of expansion. Personally, I can seen no reason why heating errors should be more serious in shunt ammeters than in a series ammeter, as Mr. Stevens states.

As for tendency to burn out on overload, hot wire instruments are now made that will stand from two to four times their maximum current. Hot wire shunt ammeters especially will stand a very heavy overload.

The resistance of the voltmeters is also a question of design, and while it may sometimes be lower than that of other designs, still, the advantages, as a whole, such as adaptability for use on direct or alternating current of any frequency, freedom from the influences of surrounding magnetic conditions, and dead beat action, make it a very desirable instrument to use.

W. J. Lloyd.

Pittsfield, Mass., October 5.

A New Convertible Car.

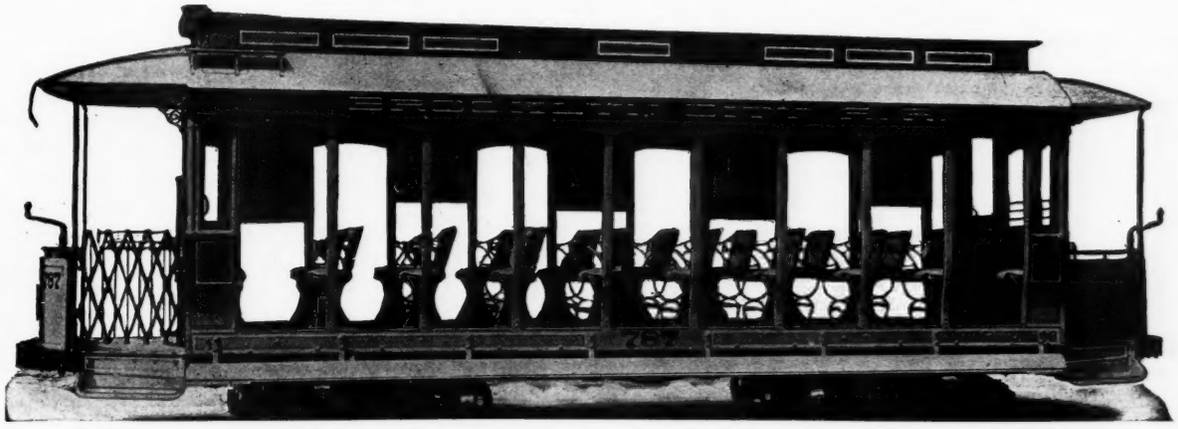
The ideal car of the street railway man is one that shall be suitable for every season of the year—a car that can be open on every warm and pleasant day and closed whenever it is cold, uncomfortable or rainy.

When street cars were first introduced the closed, or box car, answered every requirement, and the street railway manager only had a single equipment to deal with. With the advent of electrical propulsion many new troubles came, and among them was the public's universal demand for open cars. This brought complications. Cars had to have trucks to carry them and trucks had to have motors. Both trucks and motors were expensive and the manager was placed "between the devil and the deep sea." An entire service of open cars means a double equipment of bodies. This calls for double storage capacity and a large increase in capital. Cars can not, on a large system, be changed at once from one set of trucks and motors to another; it takes time and it costs money. When it is done it must be done for the whole season, so the manager must wait until he is sure the warm Summer or Spring weather is well settled before he gets out his open cars. In the mean time his patrons grumble at the delay. In the Fall, unless he is willing to stand a great many just complaints, he must have the changing well advanced before the Indian Summer is finished, losing thereby a good amount of profitable pleasure travel.

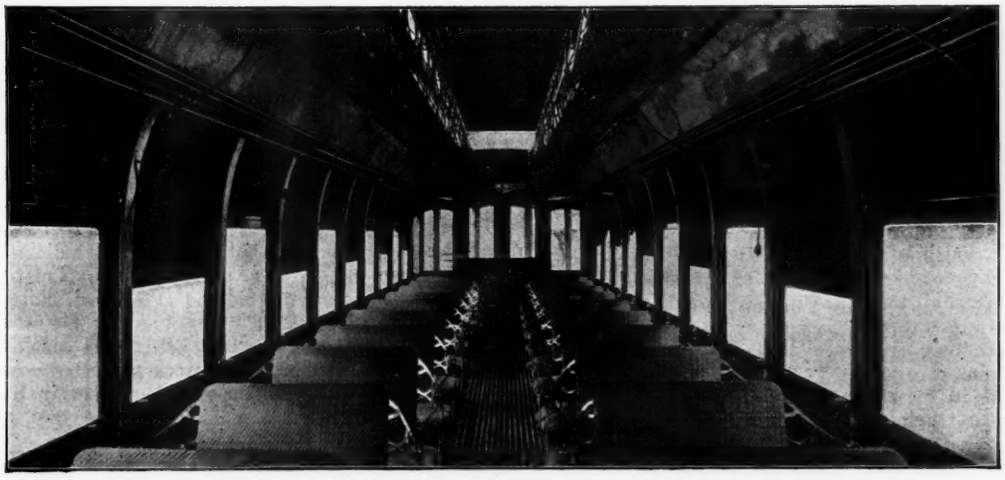
If he is very anxious to please the Summer riders and puts in a complete double equipment of cars, trucks and motors he has a worse enemy to face than even an angry public. There is an increase of capital with its interest account and a board of directors likely to ask questions. To the interest is added the expenses of the large barns and the various items of extensive storage.

The manager's problems are not simple and the public demand for an open car on any warm day, no matter what the season may be and their equally imperative demand to have it promptly taken off at the first suggestion of cold or unpleasantness do not tend to make street railroading a pleasant occupation.

It is not necessary to speak of the numerous attempts that have been made to devise a form of car that should be suitable for both Winter and Summer use. These so-called convertible cars have either failed or developed faults which prevented them from strictly meeting all the demands.



Exterior View of New Type of Convertible Car.



Interior of New Convertible Car.

Some 25 years ago the J. G. Brill Company began a series of experiments relating to the construction of a convertible car for street railways. A little more than two years ago their Mr. John A. Brill went a few steps further in this direction and designed a car which appears to meet the requirements of a car adapted for Winter use and yet capable of being transformed in a few minutes into a perfect Summer car, the change from one style to the other being the work of the conductor with no more effort than that needed to open or close windows. In either form it may be called a standard car. To the unexperienced it is, in either form, the same as cars of the usual types. The interior finish is like that of an ordinary street car. The exterior presents one or two slight differences from a standard box car

as there are folded steps at the sides and the posts show at the panels. The engravings present views of these cars both open and closed. From these it may be seen that the points of difference are not easily detected.

The construction is ingenious. Each pair of posts carries a set of hinged sliding sash and an elastic panel. These are all held in a groove in which they are movable. In the lower section of the roof there is space for a roof pocket into which all these parts slide completely out of sight and out of the way. The sash are of the usual pattern, but in two parts. The panel, which forms the side when closed, is made of two sheets of elastic, flexible metal. They are joined and strengthened by slats between them. The elasticity of this panel enables it to conform to the varying curves of the posts and to slide up into the roof underneath the glass.

In closing the car the panels are first brought down and pushed into place. This exposes the lock for the sash which are then pulled into place. The time required for closing or opening a whole car is usually not more than five minutes. It can be done by the conductor while the car is in motion. There are inside curtains of the usual type. When the car is open they may be pulled down to the floor as in any open car. When closed they come to the bottom of the sash as in closed cars. When closed the car is as warm and weather-proof as any box car. It has the usual aisle and platforms for entrance. The windows are of the ordinary size and form. When open there are the usual steps and side entrances.

This car, then, has the advantage of providing the street railway manager with just the style of car he wants at the moment that he needs it. If a raw, cold afternoon follows a delightful, balmy morning, all the open cars are transformed to closed cars and the public which went out to the gardens does not have to shiver on the way back. But more than all this, while the pleasant, open cars are earning extra sums by attracting riders there is no heavy capital account to take care of. There is no idle rolling stock in the car barn. The change from open to closed cars has not been a costly matter extending over weeks of time. And lastly, and perhaps as important as any other on some accounts, is the fact that if a cold wave strikes the town in the afternoon or a sudden, heavy storm comes up all the cars will be closed within five minutes and the passengers all protected.

These cars have been in service long enough to show that they are as satisfactory in actual practice as they are in theory.

CABLE STEAMER ORIZABA A TOTAL LOSS.

BLAME LAID ON GOVERNMENT HYDROGRAPHIC BUREAU—THE CABLE WAS PUT ASHORE SEPTEMBER 23 AND IS PROBABLY LAID BY THIS TIME.

The Pacific Coast Steamship Company's vessel Orizaba, which was wrecked on Rock Point Reef, St. Michaels Island, on September 20, is a total loss, and her captain lays the blame upon the United States Hydrographic Bureau, stating that the wreck was due to three large uncharted rocks where the charts drawn up by the bureau showed 36 feet of clear water.

Almost immediately after the accident a lighter came alongside the disabled steamer and offered assistance for $175 per hour, which was refused, and within two days several of the steamship company's boats were at work on the Orizaba trying to float her. As she had three large holes stove in her bottom, this was found to be impossible and the lighters at once began to remove the cable. This heavy task was accomplished on September 23, and the entire cable was found to be uninjured.

Mr. George F. Porter, who was with the expedition and in charge of the Kerite cable, notified Mr. W. R. Brixey, New York, on Monday morning, that he expected to finish laying the entire cable in the course of a few days. The lines to be laid run from St. Michaels to Cape Nome on the one side and to Unalaklik on the other, taking the form of the letter V, with St. Michaels at the base, Cape Nome the left terminus, and Unalaklik the right, the lines being respectively 32 and 155 miles long.

Mr. Porter's idea was to charter a steamboat and run at least the shorter cable before the sound freezes, which generally occurs about October 15. This undertaking is attended with great danger on account of the swiftness with which the ice moves, great bergs appearing without warning in such numbers as to make it impossible for a ship so trapped to escape, and once caught in the floes or heavy drift ice the unfortunate vessel, if not crushed like an eggshell, would be compelled to remain a prisoner all winter. It may be possible to run only the shorter cable, but it was thought at Mr. Brixey's office that Mr. Porter would probably succeed in laying both lines. General A. W. Greely, chief of the United States Signal Service, who returned to Washington *via* Seattle on the day of the wreck, has refused to fix the responsibility of the wreck upon anyone, claiming that he was not an expert in such matters, but adding significantly that the Orizaba's master blames his charts. In this same connection, it is reported that important changes are to be made in the Hydrographic Bureau, which seems to support the belief that the charts were incomplete and imperfect.

Wall Street and the Electrical Stock Market.

The past week has been comparatively active in all directions. This is probably due to a growing belief in the certainty of President McKinley's reelection and to optimistic views concerning the settlement of the coal miners' strike. The movements of the money market throughout the week have not been of a positive character and a general optimism prevails.

On the New York Stock Exchange, General Electric closed the week at 137 bid and 137½ asked, showing a gain of 2½ points for the week. Metropolitan Street Railway, of New York, closed at 150 bid and 151 asked, showing a gain of 2½ points for the week and bringing the stock nearly up to the point from which it began to decline several weeks ago. Third Avenue Railroad, of New York, closed at 110½ bid and 111½ asked, indicating a gain of 2 points. Brooklyn Rapid Transit closed at 52⅜ bid and 52½ asked, showing an increase of 1¾ points for the week. Manhattan Railway, of New York, closed at 90¾ bid and 91 asked, showing a gain of 4¼ points for the week and 5¾ points in two weeks.

On the Boston exchange, American Telephone and Telegraph closed at 138 bid and 139 asked, showing a gain of 3 points for the week. Erie Telephone closed at 95 bid and 97 asked, indicating a decline in price of 1 point during the week.

On the Philadelphia exchange, Electric Storage Battery closed at 60 bid and 65 asked. Electric Company of America closed at 8⅞ bid and 9 asked, indicating a gain of ⅝ point. Union Traction closed at 31¼ bid and 31⅜ asked, indicating a gain of 2⅛ points for the week, which only partially offsets the considerable decline in this stock noted last week.

On the curb, or outside market, in New York, Electric Vehicle closed at 18½ bid and 21 asked, showing a decline of 1 point for the week. Electric Boat closed at 13 bid and 16 asked, showing a decline of 1 point in the asked price for the week.

Wall street, October 5.

A large mower and reaper works, in Latrobe, Pa., has been bought by the National Wire and Cable Company, of Pittsburgh, for $100,000, and active manufacturing will be begun at once.

THE AMERICAN STREET RAILWAY ASSOCIATION.

THE CONVENTION AT KANSAS CITY THIS WEEK.

The nineteenth annual convention of the American Street Railway Association, which is to be held at Kansas City, October 16 to 19, will not only be attended by a large eastern delegation, but the western street railway men will be more largely represented than has been the case for several years. The location of the convention at Kansas City has proven a popular one in this respect, and the leading street railway men of the South and far West will be present. The exhibits will be quite numerous and will represent the latest improvements.

The officers of the association are the following named gentlemen:

President: John M. Roach, general manager Chicago Union Traction Company, Chicago, Ill.

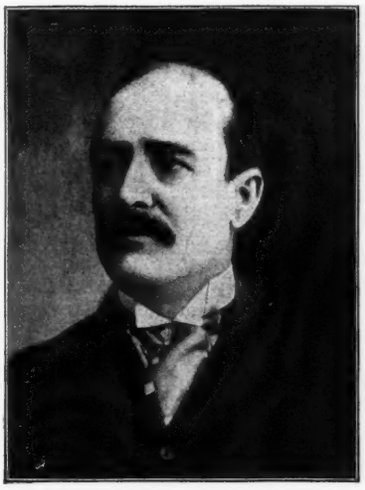
First vice-president: John A. Rigg, president Union Traction Company, Reading, Pa. Second vice-president: H. H. Vreeland, president Metropolitan Street Railroad Company, New York city. Third vice-president: F. G. Jones, vice-president Memphis Street Railway Company, Memphis, Tenn.

Secretary and treasurer: T. C. Penington, treasurer Chicago City Railway Company, Chicago, Ill.

Executive committee: President, vice-presidents and Messrs. C. S. Sergeant, second vice-president Boston Elevated Railroad Company, Boston, Mass.; C. K. Durbin, general superintendent Denver Consolidated Tramway Company, Denver, Colo.; Nicholas S. Hill, Jr., general manager Charleston Consolidated Street Railway and Electric Company, Charleston, S. C.; Charles W. Wason, president Cleveland, Painesville & Eastern Railroad Company, Cleveland, Ohio, and John R. Graham, president Quincy & Boston Street Railway Company, Quincy, Mass.

The session will begin Tuesday and continue through Wednesday and Thursday. Friday has been set apart as the day for inspection by the delegates and visitors of all the exhibits.

The special train from the east will leave the Grand Central Depot, New York city, at 10 o'clock A. M., Sunday, October 14, and will arrive in Kansas City Monday evening at 9.30 o'clock. About 100 passengers, it is expected, will be with the party at the start and additional delegates and visitors to the convention will join the train at Albany, Syracuse, Rochester, Buffalo, Erie, Cleveland, Indianapolis, St. Louis and other points along the line. The train will leave Albany at 1.30 P. M., eastern time, and will leave Buffalo at 7.40 P. M., central time. It will go over the New York Central, Lake Shore, Big Four and Wabash railroads, and a special representative of the New York Central will accompany the party through. A dining car and buffet smoking car form part of the equipment. All who expect to go who have not engaged accommodations should communicate at once with Mr. M. C. Roach, general eastern passenger agent of the New York Central Railroad, 1216 Broadway, New York city.



MR. JOHN M. ROACH, PRESIDENT AMERICAN STREET RAILWAY ASSOCIATION.

The Improved "Electrical Review."

[*From The Construction News.*]

The *Construction News* takes pleasure in complimenting the ELECTRICAL REVIEW on the handsome appearance of its issue of September 12, the first since this publication moved into new and larger quarters. Typographically, the journal is much improved and both the amount and quality of reading matter give substantial proof of increasing activity in the electrical field and of the REVIEW's determination to keep pace with the expansion in this particular and important branch of American industry. The *Construction News* wishes the REVIEW continued and merited success.

The Seoul, Corea, electric tramway has been recently extended to Riong-San, a river port, the total length now in operation being eight and three-quarter miles. The road carries freight as well as passengers, averaging about 2,068 fares a day.

Alexander Cochrane the Successor to John E. Hudson.

The sudden death of Mr. John E. Hudson, for many years president of the American Bell Telephone and the American Telephone and Telegraph Company, has naturally caused many surmises to be published as to who will succeed to his responsibilities. His death left as the executive head of the American Telephone and Telegraph Company, Mr. Edward J. Hall, vice-president and general manager. This company had recently taken over the American Bell Telephone Company, although the organization of the latter company still remains. There is no vice-president of the American Bell Telephone Company. Mr. C. J. French is the general manager. At a meeting of the board last week Mr. Alexander Cochrane was elected president pro tem. of the American Telephone and Telegraph Company and the American Bell Telephone Company. The matter of selecting a permanent president has been left with the executive committee of the two corporations. The vacancy in the board caused by Mr. Hudson's death was not filled.

The present board of directors of the American Bell Company is composed of the following named gentlemen: Francis Blake, Alex Cochrane, Henry S. Howe, Charles Eustis Hubbard, John E. Hudson (now deceased), Charles E. Perkins, Thomas Sanders, Moses Williams, C. W. Amory, George L. Bradley, T. Jefferson Coolidge, Jr., J. Malcom Forbes, Thomas B. Bailey.

The names of stockholders of the company owning 1,000 shares or more are given below:

Ayer, Fred,	1,168
Bell, Mabel G.,	1,500
Blake Brothers & Company,	1,287
Bowditch, Jas. H.,	1,100
Converse, E. S.,	1,000
Cochrane, Alex & Company,	1,070
Cotton, Wm. C.,	1,050
Crane, W. Murray,	4,400
Crane, Zenas,	4,200
Day, R. L. & Company,	1,342
Esterbrook & Company,	1,744
Fay, Jos. S., Jr.,	1,100
Graham, J. M.,	1,390
Lowell Augustus,	1,540
Lowell, Percival,	1,696
Moffatt & White,	1,405
Prescott, E. C.,	1,388
Stanley, F. F.,	1,807
Vail, Theo. N.,	1,929
Vermilye & Company,	1,494
Gray, Horace,	1,025
Grew, Edw. S.,	1,000
Head, Charles & Company,	1,635
Watson, Thomas A.,	1,610
Wright, Esther F.,	1,525
Wright, Mary F.,	1,000

Automobiles

The politicians of one of the national parties, at Mt. Vernon, N. Y., have introduced a novelty into their campaign in the form of an automobile, from which the local candidate for assemblyman will conduct his spell-binding. It is reported that he expects to cover considerably more territory with the machine than his opponent can by employing the usual methods.

M. J. Harrington, the Republican candidate for the State Senate in the Twenty-first District, New York city, began an automobile campaign last week that he intends to keep up until election day. On Thursday evening, Mr. Harrington, William Bruce Mann and Frank K. Bowers climbed into an automobile in front of the Fifth Avenue Hotel, and started for the Twenty-first. Besides its sidelights the machine had a headlight of 250 candlepower and two clusters of electric lights displayed on poles, one on each side. It bore a banner on which was inscribed, "Harrington for Senator."

Taking into consideration the small number of vehicles the New England Electric Vehicle Transportation Company has had in operation during the past Summer, the season has been a very prosperous one, especially at Newport, R. I., where 75 open conveyances were leased by the month and the demand exceeded the supply. The company has 100 cabs and 50 delivery wagons in service in Boston, Mass., and has equipped its main station there with apparatus for the automatic recharging of its machines, thus saving a considerable portion of the operating expense. It is also doing away with pneumatic tires entirely, substituting for them solid tires, which are nearly twice as longlived, running, on the average, 4,000 miles to 2,000 to 2,500 miles for the pneumatic, besides which the solid tire costs nothing for repairs.

New England Transportation stock sold at three and one-eighth and closed unchanged at three bid, last week. In view of the discussions as to the real situation of the affairs of the New England, as well as of the other electric transportation companies, interest attaches to an official statement by an officer of the New England Transportation Company, received in the street a few days ago. It shows that the company owns 100 electric cabs, besides a number of delivery automobiles, and has in operation a central station in Boston, which is now being enlarged to meet the increased demand for the company's services. Moreover, the company is operating electric vehicles in Newport, and it is expected that this branch of its business will this year show a fairly large net return, though it was fully established only late in the Summer. Apart from this the company has in its treasury about $1,000,000 in cash, or enough to retire the stock at about $4 a share.

United States Consul Monaghan forwards the following regulations covering the running of automobiles in Chemnitz, Germany:

1. Persons under 15 years of age and persons who have no knowledge as to the management of such machines shall not be intrusted with the running of automobiles.

2. All persons who do not give their undivided attention to the management of automobiles, or who, while using the same, fall asleep or get intoxicated, are liable to punishment.

3. The signal to turn out shall be "Heeh." The use of signal horns will be permitted until further notice.

4. Every automobile must carry at least one very good lantern; the same shall be lighted at the same time as the street lights.

5. The speed of automobiles in the city shall not be faster than that of an ordinary trotting horse.

No one shall run an automobile faster than a horse walks:

a. On leaving buildings or sheds bordering on the street.

b. During church service in the neighborhood of churches.

d. In places where there is large foot traffic.

e. In places where fast driving is forbidden.

6. Automobiles shall not be left unattended on the street.

Anyone disobeying these rules shall be punished.

The "pompiers," or firemen, of Paris, who have been long held up to ridicule of the rest of the world on account of the ancient and inefficient methods followed in fire fighting, have recently reversed the order of things, as the department of Paris now has the most thoroughly up-to-date apparatus in the world. The Paris fire department has just been equipped with a set of electric automobile carriages, fire trucks, hook and ladder trucks and hose carts, all unique in their way and not possessed as yet by any other body of fire fighters in the world. An exhibition of these automobiles was given by the Paris firemen, at Vincennes, recently, on the occasion of the International Congress of Firemen, and it proved entirely satisfactory, the new machines being shown to be more speedy, more easily run and more cleverly manœuvered than the apparatus drawn by horses. There are three new types of the electric automobile fire apparatus—the electric engine, the hose carriage and the hook and ladder carriage. The engine consists of a cylinder containing 100 gallons of water, mounted on an electric automobile carriage, and provided with a pump and hose. The electric motor which is used to propel the carriage to the scene of the fire at a speed of 36 miles an hour, serves, after its arrival, to pump the 100 gallons of water upon the flames. In the few minutes' time during which this supply of water lasts, the hose is attached to the supply pipes and the engine pumps a heavy stream. The hose carriage and the hook and ladder cart are similar to those in use in American cities, except that they are mounted upon electric automobile trucks and have a greater capacity for carrying men, hose and ladders and various kinds of apparatus for saving lives at fires. These automobiles will run a distance of 40 miles without being recharged.

Lieutenant-General Miles, in his annual report to the Secretary of War, will renew his recommendation for the further use of the automobile in the army. There are now at Fort Myer, Virginia, three automobiles, but they have not proved quite satisfactory on account of lack of facilities for recharging them with electricity. Meanwhile, General Miles and other officers interested in making the automobile useful for the army, have been making trials of powers other than electricity, with a view of making the machine available for military purposes. General Miles says that automobiles may be adapted for the use of couriers, carrying despatches, for movement of staff officers from one command to another, for small reconnoitering parties, for investigating the topography of the country in which the army proposes to operate, for small detachments engaged in constructing bridges or establishing depots, for rapidly supplying ammunition, and for the movement and care of the wounded. In fact, in cases where small detachments operate, the General thinks that automobiles will be found useful. General Miles thinks that the machines at present will be better adapted to the headquarters of the army, the headquarters of the departments and in posts of considerable size. In such places the automobile will be found useful for small errands and for general utility in carrying officers from point to point in and about the headquarters or the post. The bicycle, which has been used in the army, has been found very useful, especially in posts where there are no telephones. General Miles says that, as the automobile is perfected, it will grow in favor, and believes that as the machine is improved and perfected, it will be a valuable acquisition to the army.

An Independent Rail Joint.

As everybody knows, the weakness of practically all systems of track construction is in the joints. A number of more or less elaborate devices for the stiffening and strengthening of rail joints have been brought forward and exploited, but with practically all of them, sooner or later, the rail ends wear and when this wear once begins, the wheels of passing trains or cars falling into the small depression continually tend to enlarge it and make the track more and more unfit for service.

The accompanying illustrations represent, in perspective and cross-section, a new type of rail joint coming from Germany, where it is known as the "Stossfangschiene"; in America, it is called the Barschall rail joint, and is being introduced rapidly upon steam and electric railways in the United States by Mr. M. Barschall, 31 Nassau street, New York. The construction of this joint is such that, at the instant of passing the rail-ends, the tread of the wheel runs upon an auxiliary rail laid outside the joint, and thus really never encounters a break at any point. The joint is so well shown in Fig. 1 as scarcely to require description. Three pieces are used in connection with the rails; that to the left being the auxiliary rail, that between this piece and the web of the T rail being known as the "filler," while the right-hand piece is the fish-plate.

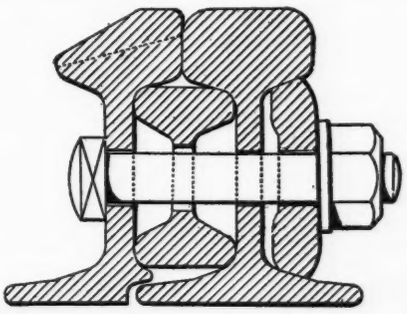


FIG. 1.—CROSS SECTION OF AN INDEPENDENT RAIL JOINT.

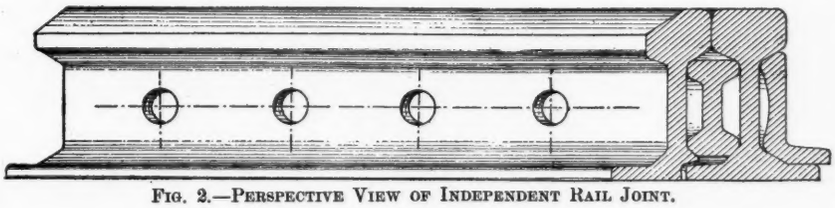


FIG. 2.—PERSPECTIVE VIEW OF INDEPENDENT RAIL JOINT.

On account of its peculiar shape and construction, the intermediate piece or filler distributes the pressure between the main rail and the auxiliary rail, while the elasticity of the ties and ballast secures an equalization of the active resistances. The introduction of the auxiliary rail lengthens the joint about 80 per cent, and by thus distributing the load over several ties, produces a track, which, for smoothness of running, is extraordinary. When old rails, especially if they be of the T-rail type, are ordinarily thought to be fit candidates for the scrap-heap on account of worn ends, it is claimed that this system is able practically to renew the track by the action of the auxiliary portion at the point where discontinuity existed before. Upon the Prussian state railways, a very large number of these joints have been installed upon old rail, while much of the Austrian railway system is constructed with them. They have a singular advantage for electric railways in the ample protection they assure for rail bonds and the ease with which these can be inspected and maintained, if necessary, after the track is laid and in position. It is claimed by the manufacturer that track bonded with this system is as noiseless as perfectly continuous rails would prove to be under similar conditions.

A Three-Way Jack for Express Switchboards.

The accompanying illustration shows an improved jack for use on extended toll lines to obviate a difficulty that has frequently been encountered in the operation of such lines when persons at two intermediate points desire to talk. Under these circumstances the balance of the line is inoperative and two distinct conversations can not be carried on over parts of the same line without the use of some such apparatus as is here illustrated. The device makes it possible to divide up a line in actual use into as many parts as may be necessary and immediately after the conversations are over, the line is restored to its original free condition from end to end. This ingenious little piece of apparatus is manufactured by the Eureka Electric Company, of Chicago.

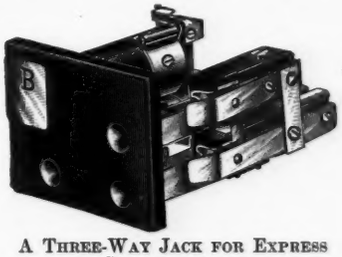
A trolley car left the track at Cincinnati, Ohio, Saturday evening, and went over an embankment of 30 feet depth. One person was fatally injured and five or six others were hurt seriously.

Cooper Union Free Day Schools.

The circular of information of the Cooper Union Free Day Schools, for the Winter of 1900-1901, has just been issued. The equipment of the laboratories is sufficient to provide for practical instruction with three years' course of study in either electrical, civil or mechanical engineering. The physical laboratories are well furnished and the electrical laboratory is equipped with both direct and alternating-current machines and all the necessary electrical apparatus for the use of students and instructors. The course is well arranged and is in care of competent instructors, Mr. William A. Anthony having charge of the department for mechanical and electrical engineering. The Cooper Union has always been noted as a philanthropic institution of the highest class, and the good work it has done in this community has possibly even exceeded the benevolent ideas of its founder.

Paris Exposition Prizes for the John A. Roebling's Sons Company.

The John A. Roebling's Sons Company, of Trenton, N. J., has been awarded two "Grand Prix" and two gold medals by the authorities of the Paris Exposition for its exhibits. The company made two exhibits; one from its electrical department and the other in the Department of Metallurgy. The former embraced, among other features, a full-size model of a section of conduit-railway track, such as is used in New York city. In the metallurgical exhibit was the model of the Brooklyn Bridge, constructed in six weeks to replace one lost on the ill-fated Pauillac, the vessel which sailed away laden with exhibits and was lost with all on board.



A THREE-WAY JACK FOR EXPRESS SWITCHBOARDS.

The largest steam turbine in existence will soon be installed in the plant of the United Electric Light and Power Company, of New York. The ordinary energy developed will amount to 2,500 horsepower, but the capacity of the turbine will permit a 3,000-horse-power load. It will be direct-coupled to a 1,500-kilowatt alternating-current generator which is capable of handling 30,000 16-candle-power incandescent lamps.

High-Grade Toll-Line Switchboards.

To meet the demand for a switchboard for long-distance work that is built with reference rather to grade than to cost, the North Electric Company, of Cleveland, Ohio, has recently placed upon the market the toll-line switchboard illustrated in this article. This board has been built without reference to cost or the labor used in installing it and getting it ready for all the requirements that may be put upon this class of toll-line apparatus. The manufacturers claim that no a continuous tollboard of any dimensions. Each section is so arranged that it can be equipped with anywhere up to 30 lines for each operator's position. The board is complete in every respect, with both line clearing-out and tubular drops, these drops being claimed to be high efficiency with great impedance and perfect adjustment. The drops are exceptionally sensitive, and are claimed to be proof against cross talk. They are mounted on strips so that a whole strip of drops can be removed at one time, or each individual al, mounted in pure rubber and having mica insulation between the springs, and everything is mounted on a base made of aluminum, thus furnishing a rigid, and, at the same time, light and compact jack.

The ringing and listening keys on this board are double, so that the operator can switch in or out repeating coils as she deems necessary, and ring either way on the line, or cut the operator's circuit out, as she sees fit. It is often found, on connecting two long metallic lines that are perfectly balanced with reference to them-

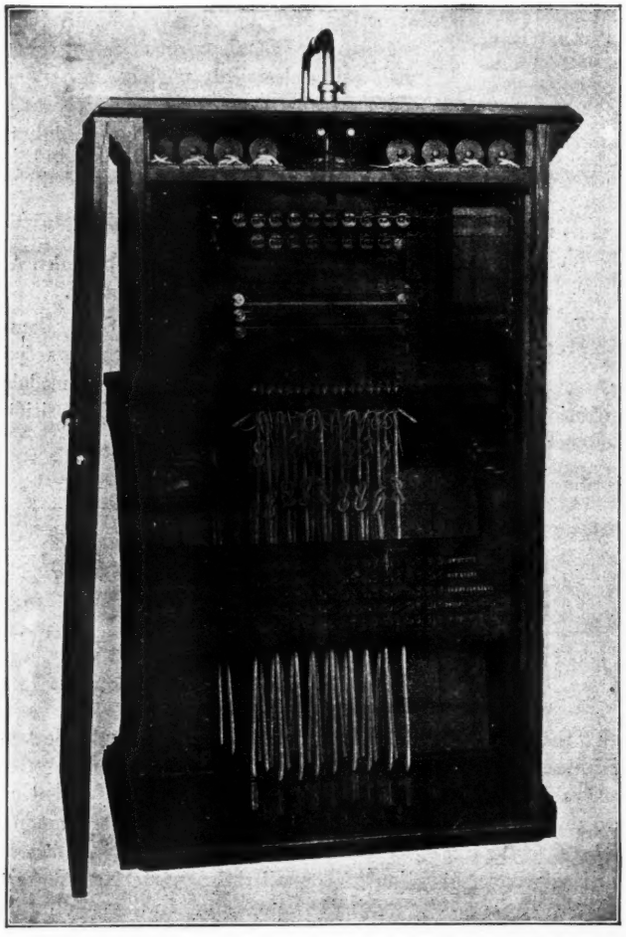


FIG. 1. REAR VIEW OF TOLL-LINE SWITCHBOARD, BACK REMOVED.

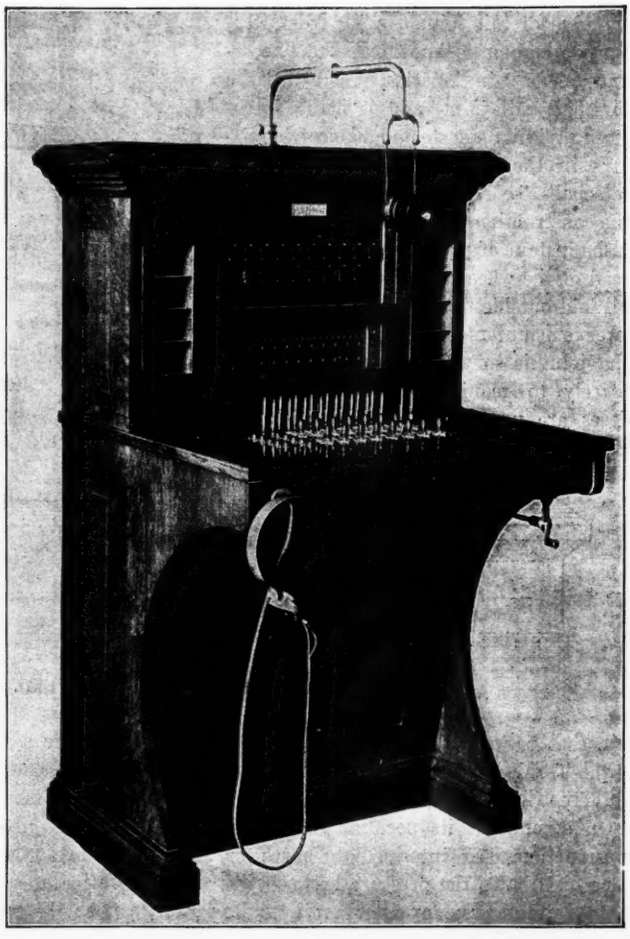


FIG. 2.—A NEW TOLL-LINE SWITCHBOARD.

board made to-day, either for use by Bell or independent companies, has higher grade of workmanship than this, or greater conveniences.

One special point which has been lost sight of in most apparatus manufactured for the independent field, has been the matter of design. This company claims that it has brought out the most handsomely designed tollboard yet offered to the independent field, the illustrations showing one of the units. These units can be added one by one, installing them alongside of each other, so that it is possible to make drop, according to the preference of the inspector. The line drops used in this switchboard are of two varieties; one, the regular type of line jack, having one jack to each line, and the other of the triple-jack variety, which enables the operator to utilize both legs of the toll-line where the same runs through the switchboard instead of terminating there. This feature is especially designed for long toll-lines passing through switchboards. It is readily seen that this increases the capacity of a toll-line for service. The jacks are platinum pointed, made of spring metselves, that, when connected together, they become noisy owing to the balance being destroyed in making the connection. It is thus often found necessary, even in the case of full metallic lines, to switch the repeating coil on the line in order to maintain the balance. This switchboard offers all these features in connection with every cord circuit, so that when the operator makes a connection and finds noise, she can simply switch in the repeating coil without interfering in any way with the conversation. The keyboard is also equipped with order wires, so that the toll-

line operator can connect with any of the operators on the city switchboard. It is also, of course, equipped with transfer jacks for same.

The rear view of the switchboard shows the repeating coil in the iron rack in the upper part of the board, the line and clearing out drops just below, triple jacks, transfer jacks, cord terminals, hand generator, night bell and terminals for all inside wiring of the board. All inside wires are brought to this terminal board properly classified and numbered, so that there is absolutely no excuse for anyone making wrong connections to this switchboard, or having to go into the wiring of the board itself. There are thus avoided a great many opportunities for trouble not usually provided against. These boards are tested before leaving the factory, and every facility is offered for quickly testing and repairing any trouble that may come up in the switchboard after its installation. The lift door in the rear is readily removed when every circuit (with the exception of the ringing and listening keys) can be traced. The ringing and listening keys and order wires can easily be inspected by raising the operator's table, which is normally kept locked.

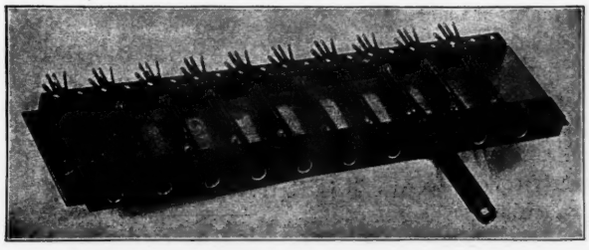


FIG. 3.—ROW OF JACKS FOR TOLL-LINE SWITCHBOARD.

An important feature on these switchboards is the character of the material used in them. Imported Swedish iron is used in the shells of both the repeating coils and tubular drops. There is no place in which anything but rubber or mica is depended upon for insulating; the only fibre used being for the handles of the plugs. The adjustable support for the transmitter is unique in many respects, it being adjustable both vertically and horizontally. The operator's receiver is of the pivoted head-band type, and the jack circuit is such that when the operator's plug is removed from the jack the transmitter battery is cut out. This is an important point in the matter of economy in transmitter battery consumption. The cabinet work in which these parts are mounted is of quarter-sawed oak, while the metal parts are in oxidized and nickel-plate finish.

ITEMS OF INTEREST.

The International Power Company will soon start the manufacture of electric and hot water "autotrucks" at its Providence works.

Surveys are being conducted at Spokane, Wash., by B. C. Riblett, for the Post Falls Electric Company, which will erect a lighting plant to cost $750,000.

The latest automobile novelty is the manufacture, by a well-known Chicago tailor, of regular and complete *chauffeur's* outfits in leather, from trousers to goggles.

Montreal, Can., authorities are considering a municipal lighting plant, as the contract now in effect for lighting the city expires on December 1. The municipal plant proposition has been favorably received so far, and it is regarded as something more than a possibility.

Several sub-stations have been installed lately in Manchester, England, and, as soon as possible after they are completed and the old cables removed, the various direct-current and cable stations in that city will be done away with. Rotary converters, with transformers and blowers, comprise the sub-station outfits.

It is announced in Boston that the Massachusetts Telephone and Telegraph Company will become an operating company by December 1. It now has 175,000 feet of duct laid in the streets of Boston, and a contract will be let this week for 40,000 additional feet, making a total of 215,000 feet, or 43 miles, of duct, which will be available for use by December 1. The number of ducts in the conduits vary from 4 to 72. The company, it is stated, has from 5,000 to 6,000 subscribers under contract. The switchboard to be used in the central station has arrived from Chicago and is being installed.

A consolidation has been effected at Montgomery, Ala., between all of the local street railways and electric companies involving a combination of over $3,000,000 of capital. The combination includes the Montgomery Light and Power Company, representing a million and a half invested; the Montgomery Street Railway Company and the water power companies of Montgomery, a million and a quarter. The bonded indebtedness of the combination will be $2,100,000. The details of the consolidation have not been arranged, but the scheme has progressed sufficiently, it is said, to make its early accomplishment a certainty.

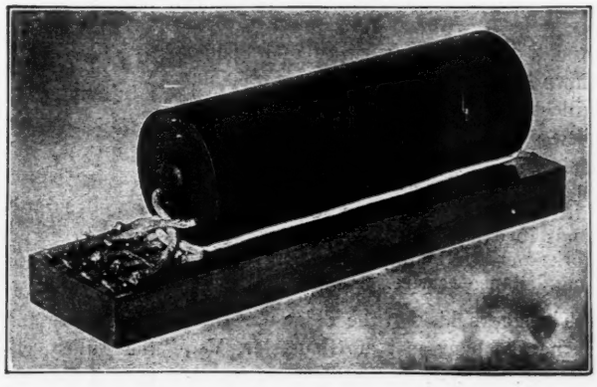


FIG. 4.—REPEATING COIL FOR TOLL-LINE SWITCHBOARD

Renewed Lamps.

While the renewal of burned-out incandescent lamps was considered somewhat as an experiment when it was first undertaken, still its successful accomplishment for several years has shown it to be a reliable process, and, at present, more and more of the larger users of lamps are taking advantage of this process. As far as the life and light of renewed lamps are concerned, they are claimed to be in all respects equal to new lamps and it is said that a saving of at least 40 per cent in the over-all cost of the lamp can be effected by its renewal. The Lynn Incandescent Lamp Company, of Lynn, Mass., is the pioneer in the renewing business in the United States and has been engaged in it for a number of years with a continually increasing output.

A Handsome Catalogue.

A very handsome catalogue has just been issued by the Electric Gas-Lighting Company, of Boston, Mass. The catalogue is provided with several interesting and novel features, among others, a side index. Its "four-department" feature is also especially interesting to those desiring information concerning electric gas lighting. The company is now carrying a full line of electric light supplies, as well as its gas-lighting specialties.

Until October 26, the municipal council of Cienfuegos, Cuba, will accept tenders for electric lighting that city.

Telephone and Telegraph

According to the *Novoe Vremya,* of St. Petersburg, Russia, the old postal telegraph system between Siberia and European Russia has proved so deficient and unsatisfactory that the matter is now receiving the consideration of the government. The first wires were laid in July, skilled men hurried to the scene of the operations, and the Siberian papers already comment favorably on the progress made.

The franchise and property of the Allegheny County Telephone Company have been purchased by parties identified with the Pittsburgh & Allegheny County & West Penn Telephone Company for a sum approximating $130,000. The exchanges included in the deal are those located at Homestead, Braddock, Rankin, North Braddock, North Versailles and Mifflin Township. It is expected that $50,000 will be expended in the reconstruction of these plants and connection made with the main exchange at Pittsburgh. With these suburban exchanges as a nucleus, the Pittsburgh & Allegheny Company intends to expand until it completely networks western Pennsylvania with a good long-distance service.

The stockholders of the Tidewater Telephone Company met at Gloucester, Va., recently. Mr. J. A. Galliger, representing the Old Dominion Steamship Company, was elected chairman, and Mr. L. C. Catlett, secretary, of the meeting. Mr. G. K. Weaver was unanimously reelected president for the ensuing year, but he declined to serve, and W. E. Corr was then unanimously elected president; Mr. A. W. Withers was unanimously elected vice-president; Messrs. J. W. Down and W. N. Trader, of Mathews; Mr. J. A. Bristow, of Middlesex, and Messrs. J. L. Tallaferro and R. B. Weaver, of Gloucester Courthouse, were elected directors. All of these, except Mr. Weaver, were members of the former board. The superintendent's report showed that the company now has 175 miles of pole line and 428 miles of wire and 107 stations in operation. Arrangements were made to open an exchange at Saluda and to extend the lines to Tappahannock as quickly as possible. More wire will be run from Saluda to Urbana, and that part of the system will be put in fine order. The question of building a line from Gloucester Courthouse to Walkerton was also discussed. This will be a step towards Richmond, whither the lines of this company will ultimately extend.

A New Battery Compound.

The widespread use of the zinc-carbon couple for battery cells makes a few words on its installation and maintenance of interest to those who use open-circuit batteries. Sal-ammoniac has long been the only chemical that was found to give even fair results in these cells, yet the insoluable crystals deposited on the elements by the solution when spent have always been a source of serious loss, while the creeping salts often did great damage to the surroundings and corroded the terminals of the cells.

Prior to the invention of the American battery compound, says its manufacturer, nothing commercially practical had been discovered to supersede the use of sal-ammoniac in zinc-carbon cells. This American compound is offered to the public as a chemical compound that is far superior to sal-ammoniac; it is said that with its use no creeping salts are produced and that its long life reduces the cost of maintenance and inspection to a minimum.

The slow polarizing properties of the compound, it is claimed, make it a superior battery salt for telephone work as well as any service requiring a small quantity of current for an extended period. On long-distance instruments that are in constant use, batteries charged with it are asserted to be nearly equal to the Fuller cell for constancy, while they excel it for long life and cleanliness. The adoption of this compound will enable exchange managers to increase the efficiency of their plants by decreasing the cost of inspection batteries and battery materials.

The solution in batteries charged with American compound has no tendency to creep or crystallize out on the edges of the cells or the elements where they enter the liquid, and thus the terminals of the cells are not destroyed by corrosion, and there is no danger or damage to the surroundings of the cells. This permits of the cells being placed anywhere with perfect safety.

The compound is put up in packages, each containing one full charge of battery compound for the standard size of sal-ammoniac cell, and, it is said, will energize it for from two to three times as long as a similar charge of sal-ammoniac. The compound, so it is claimed, does not undergo any chemical change in any climate nor does it deteriorate with age; hence any quantity can be carried in stock. It is packed in cases containing 50, 100 or 150 charges, as desired, and is manufactured by the American Battery Compound Company, 224-226 South Clinton street, Chicago.

Views, News and Interviews

The Western Union Telegraph Company announces that the Government Administrations and cable companies, whose lines are used for communication with the Far East, have agreed to send telegrams between the soldiers and sailors of the allied forces in China and their relatives at home for one-half the rate charged for commercial messages. The regular rate between New York and China is $1.60 a word.

It has been claimed in a newspaper lately that on the grounds of one of the League baseball clubs a neat and ingenious device, consisting of a buzzer in an underground box connected by wires to an observing station at some distance away, has been erected and that during the progress of a game an ex-catcher of the home team, who is thoroughly familiar with all the signs by which catchers signal pitchers in baseball, sits at the observing point and signals the captain of the team, who, in turn, communicates with the batsman, the result being that this club is amazingly successful in batting on its own grounds, but not so much so elsewhere. The story is a good one and is given for what it is worth.

On the evening of September 26 a special trolley car full of Boston people arrived at New York, having traveled practically the whole distance in electric cars. The party was in charge of Mr. R. E. Derrah, of Boston, and left that city at 8.45 A. M., Monday, September 24. Springfield, Mass., was reached the same night and New Haven on Tuesday night. The party seems to have had a delightful time and no one was tired. On the trip there were only three breaks in the trolley lines requiring recourse to the steam railways. The party met with no accidents whatever except the burning out of a fuse near New Britain, Ct.

Tenders for the erection of a telephone line between Sydney and Melbourne, a distance of about 500 miles, have been invited by the postmaster general of New South Wales, no bid to exceed £24,000. The construction of such a line is a matter requiring high engineering skill and ability and its efficiency, when complete, will depend entirely upon the thoroughness with which the work is done. It is stated that the bids have been authorized by the Premier of Victoria, after many consultations with the postmaster general.

Small Power Motors.

The apparatus shown in the accompanying illustration is designed to meet the increasing demand for small power motors of wide adaptability.

The Sterling Electric Company, of Dayton, Ohio, has followed the unique idea of perfecting but one size of frame, instead of developing a number of sizes simultaneously, where it is impossible to give the details of each machine careful attention.

It is claimed that a close study of the subject of direct driving enables the manufacturers to adopt their motor to any machine within its capacity, in the most efficient manner, by furnishing their motors, either shunt, compound or series wound and with or without special regulators, as may be required.

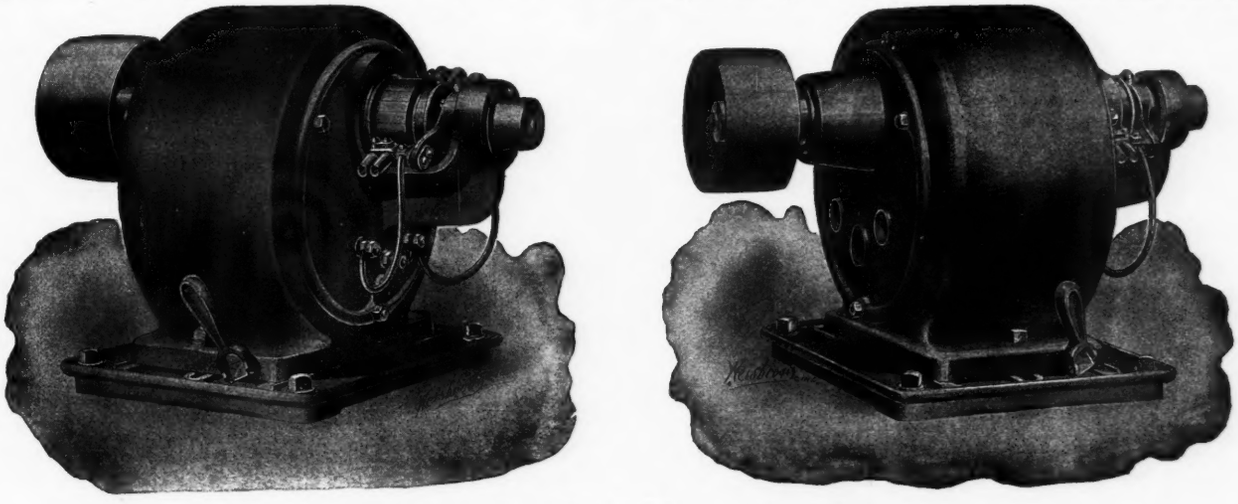
The machines are wound for from one-eighth horse-power at 250 revolutions per minute, to one horse-power at 2,000 revolutions per minute, and for all the standard voltages. A novel feature of the manufacturers' plan is to carry in stock armatures and field coils for all voltages and speeds, which they furnish when required to any customer in exchange for those sent with the motor when sold. This enables the customer to change either the voltage, speed or capacity of his motor at any time at a merely nominal cost.

As will be seen from the illustration, the machine is of unusual simplicity. It is built in strict accordance with the dictation of years of experience in successful motor manufacturing. The manufacturers guarantee these machines to be electrically and mechanically perfect.

Oil lamps of 1,000 candle-power each have been installed on the river side of the Tuileries, in Paris, as an experiment in street lighting.

Electric Lighting

Corning, N. Y., is to have a new light and power company, and articles of incorporation have already been secured. The territory embraces Corning city and town, the towns of Erwin, Big Flats and Painted Post. The capital stock is $50,000, in shares of $100 each, the duration being for a term of 50 years. The list of directors includes: Wm. K. Archibald and Frank N. Waterman, of New York; Paul T. Brady and Robert E. Drake, of Syracuse, and Alonzo F. Smith, of Corning.



Two Views of a Small Electric Motor for Power Service.

The high price of copper has had its effect, it is claimed, in retarding development in the transmission of power by electricity in large quantities east of the Rockies. The Ramapo scheme, in New York, was originally projected to bring thousands of horse-power from the Catskills to New York city, and it is said that the expectation of a lower price for wire, either copper or aluminum, stands in the way of a plan for the transmission of power from a gigantic plant, now nearly completed, of 150,000 horse-power on New York side of the St. Lawrence River, at Massena Springs, to industries in the valley of the Mohawk.

California is apparently taking the lead in the transmission of power over long distances, by the utilization of electricity, and is now at work upon the greatest feat in the world in this direction, proposing to convey electricity over heavy aluminum wires a distance of 143 miles to Oakland and San Francisco, at a pressure of 60,000 volts. The initial lines are expected to convey 14,000 horse-power. With all its lines and branches there will be 180 miles of transmission upon aluminum wire three-fourths of an inch thick, strung upon 7,000 redwood poles. This power alone can easily run the San Francisco street railway system, and scores of thousands of incandescent lights, and is only a commencement of the development of power projected by its owners.

The Fort Miller, Cal., Power Company, a corporation composed of California capitalists, has completed a two-months' survey of its property, located in Fresno County, and, according to the statement of Alfred J. Morganstern, is about ready to begin the construction of an immense flume and power house, 22 miles northeast of Fresno and two miles from the town of Pollasky. The project, according to its promoters, has for its purpose the leading out from the upper reaches of the San Joaquin River of an enormous body of water which will be carried by a wooden aqueduct for more than 10 miles and given a fall of 800 feet. After turning the wheels of certain electric generators, the water will be turned back into the channel of the stream.

Application for the incorporation of the Merchants' Gas and Electric Company, of San Francisco, Cal., was recently laid before the Secretary of State, and as soon as the certificate is issued the preliminary operations will begin. The directors named in the articles were: Vanderlynn Stow, secretary of the Thomas Day Company; Robert J. Woods, of Woods, Maillard & Schmiedell; Edward C. Hutchinson, secretary of the Kennedy Mining Company; Elliott B. Davis and A. A. Sanderson, attorneys. The capital stock is $1,000,000, of which $5,000 is paid up, each director taking $1,000 worth of stock. While the above named directors are the nominal head of the new concern, it is understood that they merely represent eastern and local capitalists.

Electric Fire Detector Cable.

Some of the recent appliances devised for use in connection with the well-known Montauk fire-detective cable, which fuses at a certain low degree of heat and completes an electric circuit, are of great interest. The accompanying illustrations show two of them, Fig. 1 being a portable fire-detecting apparatus mounted and ready for service. It consists of a six-inch gong and the necessary dry battery mounted with it in a wooden case, and a reel containing from 300 to 500 feet of the detecting cable. This can be wound around through the place intended to be protected, as, for example, about barrels and bales of goods on a wharf, or in a storage warehouse, or wherever inflammable material is gathered. The instant sufficient heat is developed to melt the fusible alloy forming a coating in the central wire of the cable this runs out through the insulation and makes contacts with the outer wires of the cable, thus forming a short-circuit through which the bell instantly rings and gives an alarm.

Fig. 2 shows a reel intended to hold the fire detective wire and intended to be permanently fastened to the interior walls of a building. The reel may be connected with a bell or annunciator, or both, and the wire reeled off and laid about among inflammable goods whenever it is desirable to do so. If the reel is connected to an annunciator drop many reels may be placed on one system, and the annunciator placed at the central office, or where it will be promptly attended to in case the bell rings, will show at once the location of a fire or dangerous heat along the cable connected to its particular reel. This apparatus as well as the detector cable, is made by the Montauk Multiphase Cable Company, of New York.

Fig. 1.—A Portable Fire Detecting Apparatus.

A New Incandescent Lamp-Cord Adjuster.

In the accompanying illustrations are shown a new incandescent lamp-cord adjuster made of fibre. The main difficulty with the older types of adjusters was that they were designed for one size of cord only. In the apparatus shown above this is obviated entirely by the crescent-shaped slot whose ends converge so as to take and securely hold any size of cord. The cord is drawn through the crescent, the ends passing through the slots as shown in Fig. 2, while another method of shortening the cord appears in Fig. 1. The article is manufactured by Frank H. Stewart & Company, of Philadelphia, Pa.

Figs 1 and 2.—A Novel Lamp-Cord Adjuster.

Mr. Paul W. Bossart, formerly of the American Electric Telephone Company, has lately associated himself with the Kellogg Switchboard and Supply Company, of Chicago. Mr. Bossart has been identified with telephone interests for a number of years, and has made an excellent reputation in that particular field.

The Pacific States Telephone and Telegraph Company.

The four telephone companies operating on the Pacific Coast, known as the Pacific Telephone and Telegraph Company, the Sunset Telephone and Telegraph Company, the Oregon Telephone and Telegraph Company and the Inland Telephone and Telegraph Company, have been incorporated under the laws of the state of Oregon into one company, to be known as the Pacific States Telephone and Telegraph Company. This company has a capital of $15,000,000, of which $10,000,000 has been issued, and takes over all the Bell companies of the Pacific Coast, which includes the territory of California, Washington, Oregon, Nevada and part of Montana. John I. Sabin is president of the company, J. C. Ainsworth is vice-president, and Louis Glass is general manager.

There are nearly 80,000 subscribers now under the control of this company, 20,200 being in the city of San Francisco. The constant increase in the city of San Francisco is very large, averaging over 500 a month. From 1,500 to 2,000 is the average increase per month in the entire territory of the company.

Mr. John I. Sabin, president of the Pacific States Telephone Company, is now visiting in the East, and will spend a few weeks in New York and Boston, and naturally is much pleased with the outlook for the increase of telephone business in his territory.

Fig. 2.—Reel for Fire Detective Wire.

Electric Fan Manufacturers' Meeting.

The manufacturers of electric fan-motor apparatus of various kinds will meet in New York, October 14 and 15, for a joint discussion of the status of the industry and for mutual acquaintanceship. Matters of considerable interest are likely to be discussed during the meeting. This will be the first annual meeting of the association, of which Mr. H. Burd Cassell, Marietta, Pa., is president, and Mr. David Chalmers, 136 Liberty street, New York, secretary.

A New Induction Integrating Wattmeter.

The extensive use of the induction wattmeter to register the energy of alternating-current circuits has created a demand for a meter that will render an accurate record of the true energy of the circuit, regardless of the power factor; one that has a permanent and reliable calibration, is convenient to handle, install and repair, and covers the broad range of adaptability met in meter service.

The meter illustrated herewith, recently developed by the Fort Wayne Electric Works, is attracting considerable attention and is said to meet the above requirements.

In the construction and operation of this instrument there are many features of interest and value. It is of a compact, smooth and well rounded design, dust, insect and moisture proof. The rotating parts consist of a light aluminum cup, supported on a carefully designed sapphire jewel spring bearing and guided at the top by a loose pin support.

The force exerted by the shunt and series coils on the aluminum cup or armature is at right angles to the plane of the shaft, thus preventing any destructive effect on the jewel bearing by the action of the magnetic field.

The rotating parts of the meter can be easily taken out by removing the top bearing and the bracket supporting the registering mechanism, making access easy to the entire internal construction of the instrument. The meter is provided with a device for overcoming static friction. It consists of a small starting coil, wound upon a laminated iron core and placed within the main shunt coil inside the armature. This small starting coil is provided with a screw adjustment by means of which it may be given an angular movement relative to the main shunt coil so that a very fine adjustment is possible.

It is claimed the accuracy of this meter on one per cent of its full load is not affected by a variation of 25 per cent in the voltage; or, in other words, a 100-volt meter will retain accurate calibration on any voltage from 75 volts to 125 volts. This result certainly marks a distinct advance in meter design, as it is said to be impossible to accomplish this result by other methods at present employed in overcoming the static friction of a meter.

A very important feature is an arrangement for adjusting the meter for any frequency. This is quickly accomplished by the soldering or unsoldering of one joint and correcting the speed of the meter by the use of the permanent magnet. The dial is made of porcelain and is dull finished, giving it the advantage of clearness and eliminating the reflection of light which often is responsible for inaccurate readings being taken. No constants are used and the amount of energy registered is read directly from the counter. The torque is high, which insures that the meter will remain in calibration for an exceedingly long time. The weight is less than 13 pounds and the meter can be installed in a space 6¾ inches by 8¾ inches.

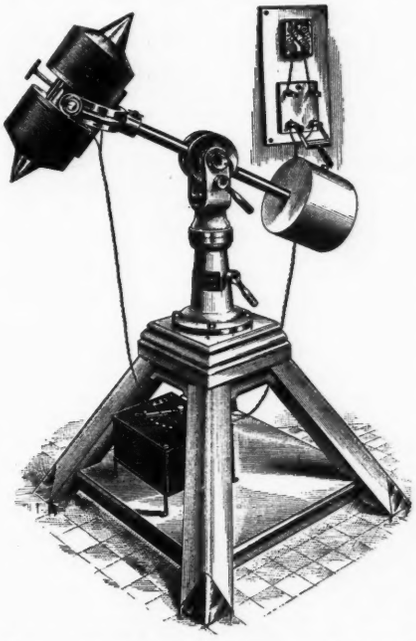
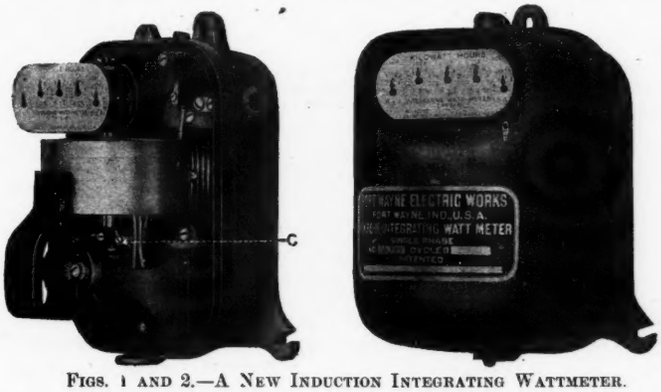


FIG. 1.—AN ELECTROMAGNET FOR REMOVING STEEL SPLINTERS FROM THE EYE.



FIGS. 1 AND 2.—A NEW INDUCTION INTEGRATING WATTMETER.

Two New Applications of Electricity to Medicine.

Very often in machine shops and other places where steel splinters are liable to be encountered, one of these strikes some person in his eye and gives rise to a painful and dangerous wound. For the extraction of these substances nothing has proved more efficacious than a powerful magnet and the illustration herewith, Fig. 1, shows a new design of mounting an electromagnet manufactured especially for this purpose. As will be noted, the magnet is provided with pointed poles, thus insuring a great density of magnetic flux at the ends of the core and is wound with coils connected through a proper rheostat and switch to some direct-current source of electrical supply. The magnet rotates on the stand and can be rested and lowered by tilting the support bar. A further adjustment is found in the gimbal joints upon which it is swung, while all of these movements are provided with safety catches so that when once placed in position they stay there.

Fig. 2 shows an ingenious arrangement which has become necessary with the increasing use of electric motors for driving surgical and dental apparatus. When these are used, if one side of the feeding circuit and part of the motor happen to be grounded, there is danger of the patient receiving a severe shock, hence the necessity for an insulated coupling. One that has been designed for this purpose is shown in Fig. 2. Both of these apparatus are constructed by E. B. Meyrowitz, New York, who also manufactures a large number of other electrical apparatus for scientific and surgical use.

FIG. 2.—INSULATING COUPLING FOR SURGICAL ELECTRIC MOTOR.

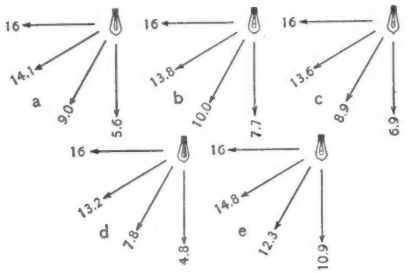
A company has just been chartered in Newark, N. J., with $100,000 capital. It will be known as the Electro-Pulsion Company, and has for its object the manufacture and application of electric motors to vehicles and conveyances of all sorts.

MISTAKES IN THE RATING OF INCANDESCENT LAMPS.*

BY PROFESSOR ARTHUR J. ROWLAND.

(*Continued from page 304.*)

There are five different types of filament in use to-day by various prominent lamp manufacturers, and in most cases a



(*a*) Straight U-shaped filament.
(*b*) Single curl filament.
(*c*) Long coil anchored filament.
(*d*) Double filament.
(*e*) Double coil filament.

FIG. 1.—SHOWING AVERAGE CANDLE-POWER DISTRIBUTION FROM INCANDESCENT LAMPS OF VARIOUS TYPES.

filament type indicates the product of a certain manufacturer who has adopted that as the one used in his standard lamps. These typical filaments are enough different from each other to show interesting individuality. I have classed them as follows:

a. Straight U-shaped filament; a type rapidly passing altogether out of use.

b. Single curl filament; a type much used, having a circular loop in the filament midway of its length. This type was originally designed to render filaments stiffer and less liable to bend without an anchor, and also to shorten the lamp bulb. It was found to give a better distribution of light than type *a*.

c. Long-curl, anchored filament; a type differing from type *b* in that the loop is long in the direction of the lamp axis and is anchored to the part of the lamp where the leading-in wires pass through the glass.

d. Double filament; a type which uses two filaments like type *a*, set so the current passes through them in series, the filaments being in planes approximately parallel.

e. Double-coil filament; a type like *b*, except that there are two turns in the coil instead of one.

Besides being typical in the matter of general form, the light distribution observed from these various filaments is also typical. It is, however, considerably influenced by the exact relation of different dimensions in the filament itself used by particular firms; as, for example, the diameter of a coil or the spread of the filament shanks. Results below are therefore departed from somewhat if different makes of lamps had been used in the tests.

Fig. 1 shows average candle-power values from lamps of each of the different types. The arrows indicate the direction from which the candle-power was measured and the number gives the candle-power. These values are true averages of the types shown. In the averages struck no "freak" lamps were included. The five types are each represented by the product of some prominent lamp maker. All the lamps are rated 16 candle-power, all were in the standard bulb used by the manufacturer of a type, and, as it happened, all were 3.5-watt, 110-volt lamps. A careful inspection of the figure shows one that the form of filament has a most important relation to the candle-power distribution, as of course it must, since the candle-power delivered in a given direction is determined almost wholly by the amount of filament length visible from that direction. A filament of type *a* shows only the end of the U when one looks in at the tip, and so the candle-power must be low, even if the U be broad. A double filament must show low candle-power for the same reason; and if the filament loops are narrow and the legs of the filaments straight, as they were in the lamps of the make tested, the candle-power may be even lower out from the tipped end than for a filament of type *a*. A filament with a coil in it shows much more projected length when viewed from the lamp's end, and so gives comparatively high candle-power in that direction. We see, then, that a 16-candle-power lamp is very different in the candle-power it gives in various directions and very different in a given direction with difference in type of filament. That lamp which gives most useful light is undoubtedly the best. Hence there is no question but that the 16 candle-power lamp with filament of type *e* is a far better lamp for general lighting purposes than any other. It is almost beyond belief that this has escaped notice in all the years incandescent lamps have been made and used, and yet it has been so. I first had my own attention called to the matter by the Shelby Electric Company, for whom I was making some tests of candle-power. It is their lamp which I show as type *e* in an attempt to find whether in the past any one had attached importance to the light coming out from the tipped end, I have been surprised to note how, over and over, this or that experimenter or lamp manufacturer has been on the verge of discovery and then passed it by. One of the most recent cases I have noticed is that of a lamp manufacturer who advertised

Filament.	Light in Given Direction in Per Cent.	
	Vertically Downward.	30° from Vertical.
Type *e*	100.	100.
" *d*	44.0	63.4
" *c*	63.7	72.4
" *b*	70.6	81.3
" *a*	51.4	73.2

FIG. 2.

sign lamps with "all the light from the end," but seems never to have thought that this would be the right sort of lamp to use as his standard product.

Fig. 2 gives the relative amount of useful light from filaments of the different sorts, expressed in per cent of the light given by the double-coil filament (type *e*).

The Shelby lamp (type *e*) for which data is given was made tipless; that is, the sealing off after exhaustion was not done as usual at the tipped end. The gain in candle-power by omitting the tip, so far as tests which I have been able to make indicate, is about 12 per cent. The loss in tipped lamps is probably due to light absorbed through the thicker glass at the tip and partly to reflection and refraction of light into useless directions which otherwise might have been saved to be useful.

What folly it turns out to be to use special devices to turn the light downward when the lamp itself can have the filament constructed so as to give a proper light distribution. A design of filament for incandescent lamps so they will give large candle-power from the tipped end is second in importance only to satisfactory efficiency and maintained candle-power with fair average life.

A large amount of light streaming from the end of the lamp is only useful if it produces a proper illumination. In Fig. 3 is plotted the illumination of a level

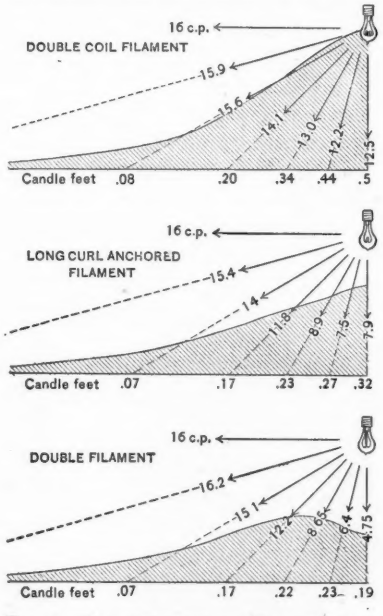


FIG. 3.—ILLUMINATION BY FILAMENTS OF DIFFERENT TYPES.

surface five feet below 16 candle-power lamps of different makes, the distribution being shown one way out from the lamp only. A single representative lamp was taken of each of three important sorts and the candle-power as marked on the diagrams determined for the light given in each of the directions shown by the arrows. The illumination was then calculated in candle-feet, and this plotted vertically from the base line. The solid curved line bounding the shaded area runs through the points so found, and all vertical distances from the base line give the

* A paper read before the Franklin Institute.

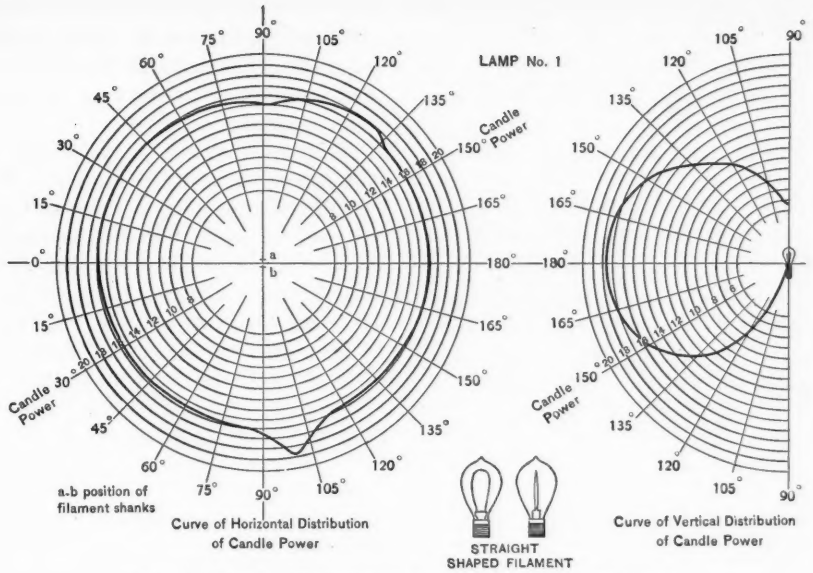

LAMP No. 1
Candle Power
a-b position of filament shanks
Curve of Horizontal Distribution of Candle Power
STRAIGHT SHAPED FILAMENT
Curve of Vertical Distribution of Candle Power

FIG. 4.—LIGHT DISTRIBUTION CURVES—U-SHAPED FILAMENT.

amount of illumination there. Some of the values found are marked. Thus, for the long curl anchored filament .32 of a candle-foot is procured at the surface illuminated by the ray giving 7.9 candle-power; .27 by the ray giving 7.5 candle-power, etc. The candle-foot unit is the common one; that is, an illumination of one candle-foot is that of a surface everywhere one foot distant from a light giving one candle-power in every direction. A surface two feet distant at every point from such a light source would have an illumination of one-quarter of a candle-foot.

A first look at the diagrams would seem to indicate that the double-filament lamp is best, since it gives more uniform illumination than either of the others. In any case, we need not concern ourselves with the light received from rays making an angle greater than 45 degrees with the vertical; since up to this angle a circular area 10 feet in diameter, above the centre of which the lamp hangs, is being lighted. Under the lamp the light is most valuable, and there we want to get most light. The double-coil filament turns out, then, to be by far the best form. If in lighting an interior the lamps were hung separately and placed about six feet apart, the evenness of the illumination produced would be about the same for lamps having double-coil filaments, or lamps having long curl anchored filaments; but the amount of illumination procured from double-coil filaments would be so much greater that they are much to be preferred. We are assuming all along that 16 candle-power lamps, as the manufacturers call them, are in use. If lamps were placed 15 feet apart, the distribution of light with double-filament lamps would be very good if an even distribution is desired; but the average illumination would be low.

(To be concluded.)

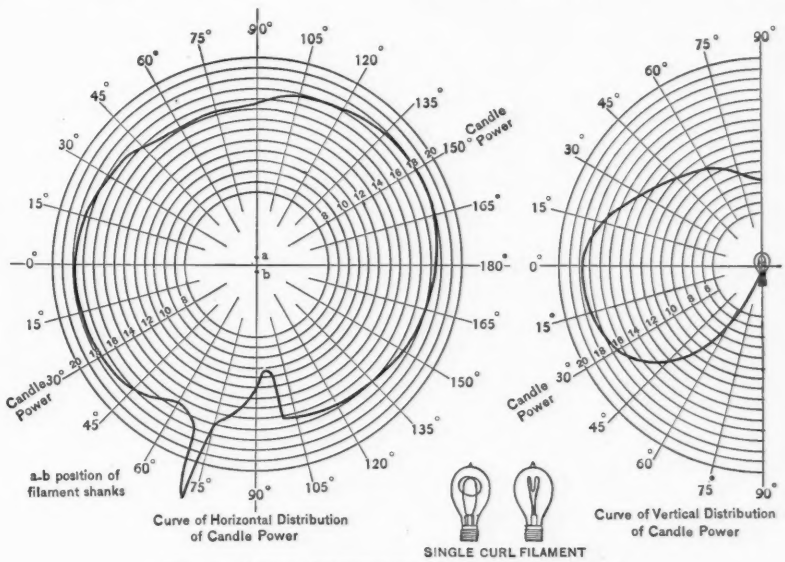

Candle Power
a-b position of filament shanks
Curve of Horizontal Distribution of Candle Power
SINGLE CURL FILAMENT
Curve of Vertical Distribution of Candle Power

FIG. 5.—LIGHT DISTRIBUTION CURVES, LAMP NO. 2.

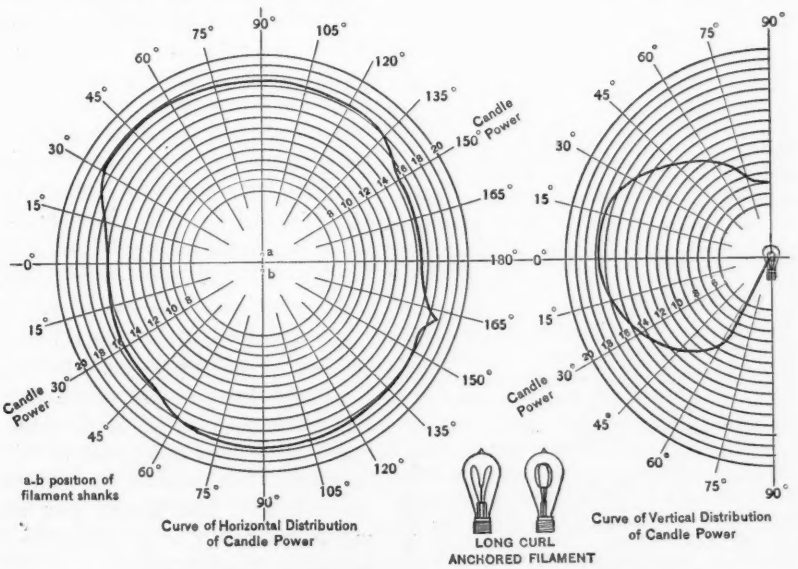

Candle Power
a-b position of filament shanks
Curve of Horizontal Distribution of Candle Power
LONG CURL ANCHORED FILAMENT
Curve of Vertical Distribution of Candle Power

FIG. 6.—LIGHT DISTRIBUTION CURVES, LAMP NO. 3.

New Protective Association.

An association has been formed for the protection of the water, electric light and gas companies of Arkansas, Iowa, Kansas, Missouri, Nebraska and Oklahoma. It is called the Water and Light Bureau of Information, and has its principal offices in Kansas City, Mo. Mr. George M. Myers has been selected as general manager of the association. Mr. Myers is personally interested in and manager of a number of water and light companies, and has had much experience in the operation of such companies.

The promoters of the Uniontown & Connellsville, Pa., Consolidated Electric Railway promise to have cars running through all parts of the coke region before many months. The line begins at Mt. Pleasant, going directly through Scottdale, Connellsville and Uniontown to Fairchance, with branches into the new Masontown coke field.

Corporation News

SHERIDAN, IND.—The Central Indiana Telephone Company has been incorporated for $10,000.

LIMA, OHIO—A recent incorporation is that of the Lima Telephone Company, with a capital of $100,000.

TACOMA, WASH.—The Acme Magnetic Traction Company has been incorporated with a capital of $100,000.

ALBION, IND.—The Noble County Telephone company has been incorporated by Thomas A. Huston, M. C. Beck and W. F. Beck; Capital, $15,000.

SPOKANE, WASH.—The capital stock of the Washington Water Power Company has been increased by a vote of the stockholders from $1,500,000 to $2,000,000.

UNION, N. Y.—G. S. Ackley, M. S. Squires and E. W. Van Slyke have recently incorporated the Lester Heights Water and Power Company; capital stock, $16,000.

FOSTORIA, OHIO—The local branch of the United States Telephone Company is rebuilding its entire plant in Fostoria, the estimates calling for a total expenditure of $125,000.

PITTSBURGH, PA. — The Allegheny County Light Company has been sold for $125,000. The officers are George Hogg, of Braddock, president, and J. M. Horner, secretary.

NEW YORK CITY—Empire Insulated Wire Company, of New York city. Capital, $25,000; directors: John E. Roeser, New York; S. B. Ferris, Madison, N. J.; J. B. Clark, Brooklyn.

CLEVELAND, OHIO—The route for a branch line from Berea to Medina has been surveyed by Captain E. J. Kennedy and the directors of the Cleveland, Elyria & Western Electric Line.

VENICE, ILL.—G. A. Niemann, M. Niemann and F. Kohl have incorporated the Venice Electric Light and Power Company, with a capital of $40,000, to operate an electric lighting plant.

GALVESTON, TEX.—The city electric lighting plant, which was wiped out of existence by the recent storm, is soon to be rebuilt. D. Hall, the superintendent, will take charge of the reconstruction.

MONACA, PA.—Right-of-way to build a line from the Ohio River Bridge to the Pittsburgh & Lake Erie Railroad station has been granted to the Monaca Street Railway Company by the town council.

DUNKIRK, N. Y.—The Dunkirk Home Telephone Company has been incorporated, with a capital stock of $100,000, by Messrs. Dale, Sudeo and Chapman, of Elyria, Ohio, and A. R. Smith, of Tonawanda.

BLOOMINGTON, ILL.—The Consumer's Heat and Electric Company was recently incorporated for $75,000, by G. S. Hanna, E. Thorp and G. E. Davis. Steam and electricity for all purposes will be furnished.

CHICAGO, ILL.—The Acme Electric Company, of Chicago, has been chartered for manufacturing electrical supplies. Capital, $5,000; incorporators: I. M. Crane, C. B. Stafford, W. Y. Miller, all of Chicago.

HUNTSVILLE, ILL.—The Shiloh Mutual Telephone Company, of Huntsville, has received a charter to operate a telephone line. Capital, $900; incorporators: E. H. Grosclaude, J. E. Croxton, T. A. Wilson, all of Huntsville.

SELMA, ALA.—It has been formally decided by the stockholders of the Selma Street Railway Company to increase its capital from $30,000 to $50,000. The directors have been authorized to build electric surface lines.

NORTH CONWAY, N. H.—The North Conway Telephone Company has been incorporated with a capital of $5,000. The incorporators are: C. E. Gibson, C. E. Poole, J. Z. Shedd, D. W. Barnes and A. Eastman, all of North Conway.

DELMAR, PA.—The Delmar & Hoytville Telephone Company, has been chartered to operate telephone lines. Capital, $2,000; incorporators: C. A. Gorris, C. A. Stewart, C. Steel, all of Delmar; D. H. Darby, of Hoytville; F. W. Marvine, of Antrim.

NYACK, N. Y.—Thirty miles of track will be laid in Rockland County by the Rockland County Traction Company, which was recently incorporated for $300,000. The termini of the road will be located at New City, Rockland Lake, and Upper Nyack.

GUTHRIE, OKLA. TER.—R. T. White, of Ft. Gill; J. F. Craig, of South MacAlester, and A. H. Howe, of New York, have incorporated the Union Electric Railway Company, at $122,000 capital stock. The company will build about 25 miles of street railway in South MacAlester.

LOS ANGELES, CAL.—The Pacific Electrical Works, with main offices in Los Angeles, has been incorporated with a capital stock of $250,000, $500 of which has been paid up. Directors: Monroe Markham, G. L. Hardison, H. E. Carse, Los Angeles; L. W. Andrews, Ventura; Frank Taylor, Brookline, Mass.

LEESBURG, VA.—An electric railway company has been organized to construct a line west and northwest through Alexandria, Fairfax and Loudon counties from Washington. The organizers are C. C. Campbell, of Fairfax County, and ex-Senator Henderson, of Missouri, who propose to erect a $60,000 power house on Mr. Campbell's farm about eight miles west of Washington. The company is capitalized at $300,000.

Electrical Machinery in South Africa.

The subjoined extract from the *British and South African Export Gazette* should prove interesting reading to American manufacturers:

"It is, perhaps, hardly 10 years since the discovery of the rich gold-bearing reefs of the Witwatersrand, but during this period the most marvelous collection of machinery of all sorts has been installed over a line of country about 40 miles in length. There is yet room for a great deal more, as it is a well-known fact that many of the small mines have never been properly developed and many of the large mines have neglected their extensions and deep levels. It will not be many months before the mines will be again occupied and the question of new electrical machinery gone into. Then will it be seen how much of the old machinery has been irreparably damaged by neglect and by water; and, inspired by confidence in the new state of things, orders will go out broadcast for this machinery and for plants which the mines have been waiting for years to put down. New schemes will be taken in hand, new districts developed, and, what is more, every bit of machinery will be wanted at once."

Manhattan Electrical Supply Company Increases Its Business.

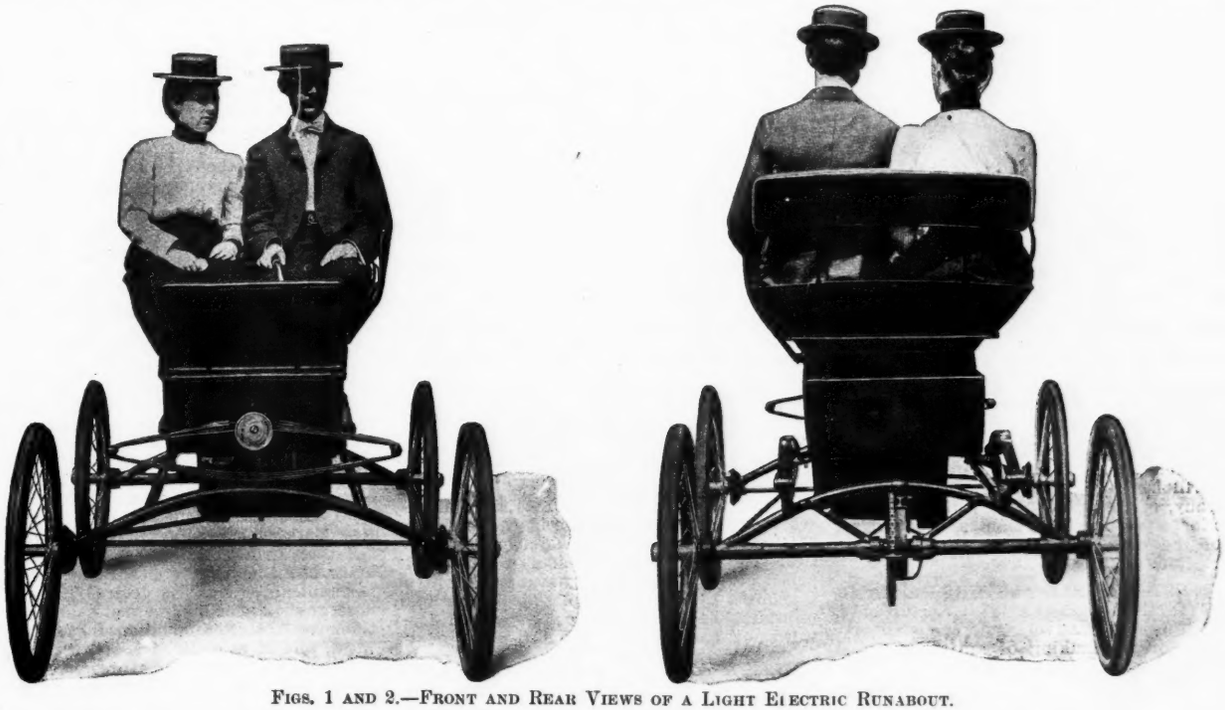
All of the patents, trade-marks, manufacturing plant and stock and business of Messrs. Huebel & Manger, of Brooklyn, N. Y., have been purchased by the Manhattan Electrical Supply Company, of New York, and, in the future, Mr. Huebel and Mr. Manger will have charge of the extensive manufacturing plant of the company in Jersey City. The large list of supplies manufactured by the former firm will be continued and many articles will be added to the list which the company is now manufacturing. Arrangements have been made for increasing the company's supply warehouses, at 32 Cortlandt street, New York, and a number of lots have been secured in Jersev City for factory purposes. The increase in the business will add about 100 employees to the pay roll of the Manhattan Company.

A company engaged in the manufacture of enclosed arc lamps has recently discontinued its multiple alternating-current, six-ampere lamp. More or less current may be used safely, but the six-ampere lamp, it is asserted, has been proven unsatisfactory, considerable risk attending its operation even under the most favorable circumstances.

A Light Electric Runabout.

For more than two years past, Mr. Walter Baker, of Cleveland, Ohio, has been experimenting with a view to bringing out a design of electromobile that should possess the great merit of lightness. Mr. Baker, in the pursuit of this design, constructed a number of carriages leading up to the finished form which is shown in the accompanying illustration.

This vehicle weighs less than 500 pounds complete, its batteries weighing only 186 pounds; but even with this small equipment of batteries as much as 30 miles on one charge has been made, and a radius of 20 miles on one charge is claimed as a reasonable allowance over average roads. The battery consists of 10 cells of 45-ampere-hour capacity, and the motor is rated at three-fourths horse-power. The controller is ordinarily arranged for two speeds, and the hand-brake is attached to it. There is also an auxiliary brake operating on the rear axle and controlled by a foot lever. The motor is, contrary to usual practice, suspended from the body of the vehicle, and is entirely covered by a casing. The chain runs from the motor shaft to the centre of the rear axle, the rear sprocket being contained in an arched frame and combined with the differential gear. The adjustment of the chain is effected by a rod which slightly moves the motor forward or backward. The framework itself is composed of steel tubing, with hickory side-bars. The wheel hubs and spokes are made of a composition metal claimed to be very tough and not liable to rust or tarnish. Baker ball bearings, which have been manufactured for a long time by the inventor of this vehicle, are used throughout. It is expected that vehicles of this type will be exhibited at the forthcoming Automobile Show, in New York city.



FIGS. 1 AND 2.—FRONT AND REAR VIEWS OF A LIGHT ELECTRIC RUNABOUT.

High Praise for Electric Ventilation.

In his report to Rear-Admiral Rogers, U. S. N., on the new battleship Alabama, Naval Constructor W. L. Capps says: "The ventilation of the Alabama, as compared with that of the Kearsarge and Kentucky, is noticeably inferior, and it is believed that the superiority of the ventilation of the Kearsarge class is largely due to the use of electrically-driven fans of high velocity. There can be no possible question as to the results obtained in the two vessels, and as the vessel ventilated by electrically-driven fans proved itself so much more satisfactory, it is strongly recommended that electrically-driven fans be substituted for steam-driven fans in all future construction, the development of electric motors at the present time being such as to entirely eliminate the experimental element from such mechanism, which might have been urged against them, with propriety, a few years ago."

A large addition is shortly to be made to the Rhode Island Locomotive Works for the manufacture of automobiles by the International Power Company, of Providence, R. I.

Postal Telegraph Office in Manchester, England, Destroyed by Fire.

A spirit lamp, which was being used by some employees of the engineering department of the Postal Telegraph Company in making repairs in the Manchester, England, office, exploded recently, firing the building and cutting off all telegraphic communication between that city and the rest of the world. The explosion occurred near a test box, where all the wires entering the building converge, and in a very short time the instruments were wrecked, the roof had fallen in and a great number of the lines destroyed. It is hoped by the Manchester officials that, with the assistance of the company's engineer in London, the damage can be speedily repaired and the 250 telegraph instruments, ruined by the fire, put into active operation again. It is very necessary that the repairs be effected immediately, as the Manchester office is, excepting London only, the busiest and largest in all England, and, at the present moment, while the reconstruction is being done, all long-distance despatches are being sent to London by train every 30 minutes, and messages for Manchester are handled in the same manner by the railroad. Until Manchester shall have recovered from the disaster, Lancashire and Yorkshire towns which were connected with the burned-out office will be connected with Liverpool for their "transmitting centre." A large amount of extra work will thus be put upon the Liverpool office, but the company expects that it will be satisfactory.

Industrial Notes

THE AMERICAN BATTERY COMPOUND COMPANY, Chicago, manufactures a battery compound for zinc-carbon cells, and a battery salt for open-circuit cells.

MANAGERS of alternating lighting plants who desire information regarding the Gutmann wattmeter should apply directly to the selling agents, the Electric Appliance Company, of Chicago.

FRED M. LOCKE, Victor, N. Y., maker of insulators, is now represented for export interests for South Africa, Australia, and Mexico, by William E. Peck & Company, 100 William street, New York.

THE LEA MANUFACTURING COMPANY, Elwood, Ind., manufacturer of the arc lamps of that name, has just placed its eastern agency with Mr. David Chalmers, 136 Liberty street, New York.

THE ALASKA TREADWELL GOLD MINING COMPANY, of Douglass Island, Alaska, operating the largest stamp mills in the world, has placed its third order with the Burt Manufacturing Company, of Akron, Ohio, for oil filters.

THE JAMES DIXON CRUCIBLE COMPANY, Jersey City, N. J., is sending out an attractive folder advertising Dixon's silica graphite paint, which is made in one grade and four colors, and designed for the protection of steel viaducts, bridges and buildings.

THE NEW SHIP BUILDING PLANT for the Risdon Iron Works, at San Francisco, Cal., will be built by the American Bridge Company, of New York, and will consist of a boiler shop, machine shop and foundry, all of the latest design and most modern description.

THE SPRINGFIELD ELECTRICAL MANUFACTURING COMPANY, Springfield, Mass., is a comparatively new company organized for the making of knife switches, switchboards and panel boards. It has placed on the market a new, patented switch with an original contact method.

J. H. WHITE MANUFACTURING COMPANY, 127-137 North Tenth street, Brooklyn, N. Y., manufactures a standard line of gas, electric and combination fixtures and trimmings, such as screws, ornaments and all the smaller elements which are contributory to electric light and gas fixture equipment.

THE ELECTRIC APPLIANCE COMPANY, Chicago, is jubilant over the fact that three of its agencies have carried off prizes at the Paris Exposition, "beyond competition," and "for high standard of excellence." The winners are the A.-B. arc lamp, Packard incandescent lamp and the Packard transformer.

THE WESTERN TELEPHONE CONSTRUCTION COMPANY, of Chicago, has lately issued a new catalogue describing completely its line of telephone apparatus and switchboards. The book is handsomely illustrated and contains much valuable information to intending purchasers. It will be mailed free upon request.

THE ALDEN ELECTRIC COMPANY, formerly Alden & Company, have lately moved into large and commodious quarters at 52 and 54 West Van Buren street, Chicago. It occupies the entire building, using 13,000 square feet of space. A full line of general electrical supplies will be carried and prompt shipments will be made at all times.

THE ELDREDGE ELECTRIC MANUFACTURING COMPANY, Springfield, Mass., is manufacturing a small battery voltmeter ranging from 0 to 3 volts, dead beat. The instrument is claimed to be a practical one applicable to primary or storage batteries, and to be the only one of the kind giving the desired electro-motive force.

M. L. BARRETT & COMPANY, Chicago, manufactures colored lacquers for incandescent lamps which produce the most brilliant rainbow colors, which it is claimed will not peel or fade and are easily applied to lamps. This company also manufactures a dead black lacquer for metal work which is said to be the most satisfactory imitation of Bauer-Barff in the market.

AT THE RECENT CONVENTION of the Master Car Builders, at Saratoga Springs, the Consolidated Railway Electric Lighting and Equipment Company, of New York, presented the delegates with a very handsome black Russia pocket and note book combined. It was one of the neatest souvenirs given out and was greatly appreciated by the many railway men in attendance.

THE HEWITT-LINDSTROM MOTOR COMPANY, 75 North Clinton street, Chicago, builder of electromobiles, has accomplished most interesting results in electric vehicle construction both as to mechanical and electrical design. The company is now making a variety of types and its omnibuses, stanhopes, breaks and delivery wagons are in successful and general operation.

THE WESTERN ELECTRIC COMPANY, Chicago, has just shipped a number of new series enclosed, alternating, arc lamps, which are to be installed at Birmingham, Ala. These will be operated on a 60-cycle alternating circuit direct from the mains. At this frequency the terminal voltage is from 78 to 80 volts, so that 26 lamps can be operated on a circuit from 2,000 to 2,080 volts, current seven amperes.

THE HOLOPHANE GLASS COMPANY, formerly at 1 Broadway, New York, has removed to new offices at 15 East Thirty-second street. The increase in the business of this company required additional facilities. Its manufacture consists of compound prism globes and shades guaranteed to give maximum light with complete diffusion and minimum of glare. The company will forward new catalogues on request.

THE AMERICAN BRIDGE COMPANY, New York, has commenced making very large shipments on account of the steel work for the subway in New York city. Already about 2,000 tons have been shipped, and the material is now being sent in at the rate of about 100 tons per day. The total contract comprises about 80,000 tons of structural material, and is being manufactured at the Keystone plant of the American Bridge Company.

TESTS OF RAIL BONDS were recently made by experts of the French Government at the Ecole d'Electricité, in Paris, and the formal report has just been issued. The results were highly favorable to the Edison-Brown plastic copper bond, which was shown to be of very high conductivity. The report of the tests in full is published in a neat pamphlet, which may be had of Mr. Harold P. Brown, 39 Cortlandt street, New York city.

THE CENTURY TELEPHONE CONSTRUCTION COMPANY, of Cleveland, Ohio, has brought out a preliminary catalogue entitled "Something New in Telephones," containing illustrations of the telephone apparatus manufactured by the company, with detailed explanations as to the construction and important features of the new Century transmitter, receivers, magneto bells, desk sets, cable terminals and other parts of desk systems.

THE VIADUCT MANUFACTURING COMPANY, Baltimore, Md., manufactures a portable telephone weighing only nine pounds, size five and one-half by five and one-half by eight inches, which is particularly adapted for linemen's use and testing purposes, or for suburban railways. It may be carried on the car by the motorman or conductor and the telephone wires brought down at certain points along the road to a long spring jack placed in a wooden or iron box.

MESSRS. THOMAS WILCOX & DIETZ, Cleveland, Ohio, report a large sale of the improved new swing-arm desk telephone No. 5, which embodies many features of novelty. The instrument is intended to be mounted in a desk and can be strung under the cover of an ordinary roll-top desk so as to be entirely out of the way. The double-pole receiver manufactured by the same firm has also been received on the market in a fashion highly gratifying to its makers.

THE DE DION-BOUTON MOTORETTE COMPANY, Church lane and Thirty-seventh street, Brooklyn, is scarcely able to fill the many orders it is receiving for its motors, motorcycles and motorettes. The company announces that it is working night and day to keep up with its orders and it is doing a larger business than ever before in its history. One of the motorette vehicles, under the guidance of Mr. C. J. Field, manager of the company, won one of the events at the recent automobile race held at the Guttenburg Fair.

THE VARLEY DUPLEX MAGNET COMPANY, Jersey City, N. J., claims to make a net charge for magnets less than the equivalent amount of insulated wire. The windings are done by automatic winding machines and are claimed to contain fourteen and eight-tenths more copper in a given winding space than is contained in an ordinary magnet. This company has recently issued some interesting literature showing by illustrations the stages in winding magnets by the Varley system.

FLEXIBLE MICANITE PLATE is a new material recently put on the market by the Mica Insulator Company, of Chicago and New York, and intended to be used wherever a flexible insulator that can withstand acids or a high temperature without losing its mechanical strength is desired. It is manufactured in sheets three feet square, in any thickness from ten one-thousandths inch upward, and it is claimed that for insulating field magnet cores, armatures, commutator shells and such other purposes it is very efficient. It will withstand 1,500 volts alternating per mil of thickness.

THE COUCH & SEELEY COMPANY, 26-28 Binford street, Boston, Mass., has just issued its new catalogue announcing its removal to the company's new factory and showing its different styles of telephone apparatus. The catalogue is one of the handsomest that has ever been published by a telephone company, and one of the most notable features in it is the beauty of the illustrations, nearly all of which are wood engravings. In this catalogue is shown a complete line of telephone apparatus, switchboards, etc., for long-distance and interior work. The catalogue is bound in cloth with silver lettering, and is noticeable for the clear and concise manner in which the different articles are described.

THE STANDARD PAINT COMPANY, New York, whose factories are in New Jersey, and Hamburg, Germany, put in its insulating papers in the cold-storage rooms and freezing tanks of the magnificent record-breaking express steamer Deutschland. These storage and refrigerating rooms are among the most interesting features of the great vessel. Naturally, they require air-tight and moisture-proof insulating materials as the temperature maintained in them is about 20 degrees Fahrenheit. While the air is kept cold, it is at the same time caused to circulate constantly and as it passes through the cooling surface from time to time its moisture is all condensed and the air becomes very dry. The same company has installed its insulating materials on the freezing tanks of many others of the large ocean ships such as the St. Louis and St. Paul, the Kaiser Wilhelm der Grosse and many others.